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Case Study No. 17

Bicycle and Pedestrian Policies and Programs in Asia, Australia, and New Zealand

National Bicycling And Walking Study

U.S. Department of Transportation
Federal Highway Administration

Foreword

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Notice

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Executive Summary

This report examines bicycle and pedestrian programs and policies in Asia, Australia, and New Zealand, with particular attention to lessons that may be useful to U.S. transportation professionals and policymakers. As such, the report looks most closely at the experience of Japan and Australia, the two most affluent countries in the region.

This region of the world includes many cities and countries highly dependent on nonmotorized transport (NMT). In many cities in both low-income China and high-income Japan, half or more of all person trips are by foot or bicycle. However, many other highly motor-vehicle dependent cities are found in the region. In many cities of Australia and New Zealand, fewer than 10 percent of trips are made by walking and cycling. This study suggests that across societies, the variation in the use of bicycling and walking modes cannot be well explained by income, climate, and the level of motorization, although clearly these have some effect. How these modes are perceived socially, how safe people feel walking and cycling, and particularly, the character of land use and urban design, and transportation pricing, all appear to play greater roles in determining the level of walking and cycling.

Australia's experience helps to show the limits of what may be achievable in promoting walking and cycling in an automobile-dependent country lacking a strong financial and policy commitment to improving the bicycle and pedestrian friendliness of streets and cities. As has been the U.S. experience, without significant changes in policy, transportation pricing, and a commitment of adequate resources, only modest positive changes in modal orientation away from the automobile can be anticipated. Japan, on the other hand, illustrates the extent to which wealthy, modern, and efficient communities can be reliant on nonmotorized transportation as an integral part of their mobility. While some elements of the Japanese experience cannot be readily transferred to the American context, many solutions and strategies are highly relevant to making America more competitive, efficient, and sustainable. Some of the key strategies from Asia, Australia, and New Zealand that merit special consideration by U.S. policymakers include:

Intermodal Bike-and-Ride Systems. The Japanese systems for bike-and-ride travel, with efficient and easy-to-use guarded bicycle parking at transit stations, offer important designs and service concepts that can enhance public transportation efficiency and effectiveness, reduce automobile dependence, and cut transit operating costs. There is a need to demonstrate and evaluate the utility of guarded bicycle parking garages at U.S. transit stations, compared with bicycle locker and rack systems that are the prevalent practice. Such demonstration projects

should be undertaken in conjunction with measures to ensure that bicycle-friendly streets and paths lead to transit stations.

Traffic Calming. The traffic-calming strategies being pursued in Japan and Australia, like those in Europe, are already finding application in a growing number of U.S. communities. The Australian and Japanese experience in this area should be more closely examined for potential transfer to the United States. Many American officials, trained to identify ways to speed up traffic and increase highway capacity, still question the idea of traffic calming. Revised handbooks, textbooks, design standards, and training materials and courses are needed to transfer the best of the foreign experience to the U.S. context and to build on the growing base of domestic experience in this area. Traffic calming appears to be one of the more cost-effective ways to promote pedestrian and bicycle use in urban and suburban areas, where walking and cycling are often hazardous and uncomfortable.

Pedestrian and Bicycle Priority Areas. The Japanese and Australians are both expanding the application of traffic-calming strategies across whole networks of streets in areas where pedestrians and bicycles are given priority. This concept is applicable to residential and commercial areas and near major transit stations and should be investigated in the United States.

Traffic Cells. The traffic cell systems of Japanese cities should be more closely examined by U.S. transportation planners. Like their counterparts in Europe, these have proven very effective in discouraging through traffic and shifting short trips within the area to nonmotorized or public transportation modes. They offer major potential for air pollution reduction through the elimination of short trips, with their cold starts and hot soaks. The Downtown Crossing in Boston, Massachusetts, represents a successful demonstration of this concept in a major U.S. city.

Part-Time Pedestrian Zones. The use of part-time pedestrian zones is common in Japan and should be considered for U.S. communities. By allowing automobile and truck access in the early mornings and restricting access to pedestrians and cyclists in the midday and evening, such zones enable pickup and delivery needs to be met without losing opportunities to create lively people places and retail spaces during other parts of the day.

Pedestrian Amenities for the Visually Disabled. The Japanese have developed very effective information systems for the visually disabled that could be adapted and demonstrated in U.S. cities to support implementation of the Americans with Disabilities Act of 1990. Other information systems for pedestrians being tested in Japan might offer a new dimension to the IVHS research agenda of the U.S Department of Transportation.

Bicycle and Pedestrian Facility and Network Design. The Japanese experience in this area is quite different from that of the United States and offers many innovative, useful, and adaptable concepts that could be applied in American communities. Creating denser networks of bicycle-friendly paths, lanes, and roads is important if more than a small minority of the population is to find utilitarian cycling attractive in an otherwise motor vehicle-dominated environment. Various types of facilities can compose the network, from mixed traffic streets that are pedestrian and bicycle friendly to fully separated pedestrian and bicycle paths. To be most effective, networks need to penetrate into the hearts of major urban and suburban centers, to reach rail stations, employment centers, and retail areas, connecting them to residential areas and schools. These concepts merit discussion in traffic engineering manuals, design guidelines, and training.

Pedestrian and Bicycle Supportive Land Use Planning. The experience of Asia, Australia, and New Zealand also shows the importance of land use planning and policy on bicycle and pedestrian travel. Moderate and higher density mixed-use patterns of land development, as are found in Japan and many Asian cities, favor far greater use of walking and cycling by reducing the distance people must travel to meet daily activity needs. Restricting parking supply, encouraging minimal building setbacks, placing parking behind buildings rather than in front, and encouraging small retail establishments in residential areas can all promote walking and cycling. Such policies merit consideration as strategies for transportation demand management and air quality improvement in the United States. Making transportation and land use models sensitive to urban design and small-scale land use patterns could enhance their ability to simulate observable travel behavior patterns, including walking and bicycling use. Such improved models could lead to more cost-effective decisionmaking and investment, considering more fully the impacts of policies and development patterns on walking and bicycling.

Commuter Subsidies and Pricing. Fuller-cost pricing of the automobile in metropolitan regions is a significant factor in the high use of nonmotorized modes in a number of high-income Asian cities, particularly in Japan and Singapore. Motorists in Japan pay very high automobile registration fees, parking fines, gasoline taxes, and tolls. In Singapore, motorists must pay a substantial monthly fee to enter the central city area and the Government recently began to limit the number of new automobile registrations. In contrast, current transportation choices in the United States are skewed by subsidies for the automobile. U.S. State and local governments need to consider how to use such strategies to generate revenues to meet community needs while sending appropriate price signals to travelers. Fuller-cost pricing of all transportation modes, as in Japan, promotes walking and cycling, which have intrinsically low costs.

The 4-E's Approach to Bicycle Promotion. "Education, Engineering, Enforcement, and Encouragement" has been the strategy for bicycle promotion in both Australia and the United States. However, in both countries this approach has not lived up to its promise due to lack of strong Government support and financial commitment. Exercising ISTEA's new funding flexibility, State and local governments can move forward more effectively in this strategy.

Bicycle Helmet Encouragement and Laws. Australia offers the United States good examples of successful bicycle helmet encouragement programs, but also offers a cautionary experience in making helmet use mandatory. The recent requirement for all cyclists to wear helmets, under threat of fines, appears to have reduced the use of bicycles, and thus has worked against other goals of reducing automobile use and air pollution. Mandatory helmet law proposals for cyclists in the United States should be reconsidered in light of this experience.

Costs, Benefits, and Expenditures. The financial commitment of Governments in the region to pedestrian and bicycle modes is difficult to tally, but clearly, Japan and China are both expending significant resources to support greater use of these modes of transport. Japan's expenditures on pedestrian and bicycle infrastructure alone over the past two decades likely exceed US $8-10 billion in a country of 125 million people. Australia and New Zealand, while representing countries with populations one-seventh and one-thirty-fifth as large as Japan's, have likely expended significantly less per capita for nonmotorized transportation modes.

Little information on the costs, benefits, and expenditures related to pedestrian and bicycle programs is readily available. The U.S. Department of Transportation could investigate long-term, least-cost analysis methods that would be needed for a comprehensive assessment of costs and benefits of bicycle and pedestrian programs and strategies. More limited evaluations in Australia suggest that many such programs are quite positive in their return on investment. Various traffic-calming measures in Adelaide, for example, provided cost-benefit ratios of 10:1 to 1.2:1, considering accident costs alone. The Fremantle Bike Plan provided a return of 1.46:1 for its first 2 years of implementation.

As America seeks to develop a new vision of transportation and land use that will be more sustainable into the next century, it needs to look to other societies to learn and adopt the best from their experience. There is much to be gained by learning from abroad, and much to learned by efforts in America to make walking and cycling the modes of choice for short trips for a larger share of the population.

I. Introduction

There are many lessons for U.S. transportation planners and policymakers in the experience of Asia, Australia, and New Zealand with bicycle and pedestrian programs. This region of the world accounts for more than half of the world's pedestrians and two-thirds of its bicycles. It ranges from some of the poorest to some of the richest societies. Walking and cycling vary widely across the region, within countries of both low and high income, reflecting the diversity of historic and prevailing conditions and policies.

The region of Asia, Australia, and New Zealand is one of sharp contrasts. On the one hand, it includes many cities overwhelmingly dependent on nonmotorized transport (NMT), such as those of China, where more than half of all person trips are by foot or bicycle. On the other hand, it contains highly motor vehicle-dependent cities, such as those of Australia, where fewer than 10 percent of trips are made by walking and cycling.

However, income is not the key factor controlling the degree of dependence on motorized or nonmotorized modes of transport. In the capitol of the richest country in the region, Japan, nearly half of all trips are made by walking and cycling. Yet, in some of the less affluent but rapidly motorizing cities of middle-income Asia, such as Bangkok, reported bicycle and walk trips are less than a quarter of the total. Many factors account for these differences, but public policies, historical transportation and land use investment patterns, and the way that street spaces are managed have a major role in shaping these mode choices.

The region that is the focus of this study mirrors many trends seen in America and Europe. Transportation policymakers and planners in Asia, Australia, and New Zealand, as elsewhere, have tended to focus substantially more on the problems of motorized public and private transportation than on nonmotorized modes. Among bicycle, pedestrian, and highway planners, debates about where and how to integrate or separate different modes of transport—motor vehicles, bicycles, and pedestrians—continue as in America.

In many European countries, such as the Netherlands, Denmark, and Germany, there has been a strong move to separate bicycle, pedestrian, and motor vehicle traffic, except where motorized traffic volumes are relatively low and motorized transport can be slowed to ensure its greater compatibility with bicycles and pedestrians. In Japan, there has been a similar separation of slow and fast traffic, but less separation between bicycles and pedestrians, which must often share the same sidepaths. In Australia, there have been notable efforts to create separate bicycle paths or lanes, but there has been a greater emphasis on the use of wide curb lanes and integration of bicycles with motor vehicle traffic, as is common in many American communities.

Japan has witnessed major growth of bicycle use despite increased motorization, through policies providing extensive bicycle/pedestrian paths, bicycle parking at rail stations, and high fees for automobile use, as in Denmark and Holland, where the decline of bicycle use was reversed through similar policies. This has been possible due to comparatively greater political support for pedestrian and bicycle improvements than in the United States and land use and tax policies that have maintained many more opportunities for daily needs to be met by walking or cycling.

China has for several decades explicitly favored the bicycle to reduce the growth of public transport costs and energy use. China has offered employee commuter subsidies for those bicycling to work, cultivated a domestic bicycle manufacturing industry, and allocated extensive urban street space to NMV traffic. This strategy succeeded in reducing the growth of public transport subsidies while meeting most mobility needs, although growing bicycle traffic congestion now poses new problems and is spurring increased investment in public transportation. Today, 50 to 80 percent of urban vehicle trips in China are by bicycle and average journey times in China's cities appear to be comparable to those of many other more motorized Asian cities, with much more favorable consequences on the environment, petroleum dependency, transport system costs, and traffic safety.

Australia and New Zealand, on the other hand, followed the American path in early motorization of transportation, with growing automobile use, expanding highway investment, and fairly minimal policy and infrastructure support for cyclists and pedestrians. The similarity of substantial and growing automobile dependence, sprawled land use, culture, and language has encouraged interchange between bicycle planners in these countries and the United States.

In Australia and New Zealand, as in North America, bicycle planning has focused on integrating cyclists with motorized traffic and placed little emphasis on slowing traffic speeds. The primary philosophy of bicycle planners in these countries has been the "4-E's"—Engineering, Education, Enforcement, and Encouragement. While based on sound principles, this "4-E" approach to bicycle planning has had only modest success, compared to the Japanese and Chinese experience. In practice, in Australia, New Zealand, and North America, there are few communities that have provided adequate resources and policy support for the "4-E" strategy.

In these countries, funding for separate bicycle facilities has been minimal, due to relatively weaker political support for pedestrian and cyclist needs and relatively strong institutional and political support for pro-automobile policies, subsidies, and investments. In Australia and the United States, many bicycle activists have fought against separate facilities for cyclists, arguing that such facilities reinforce the perceived inferiority of cyclists and contribute to safety problems. Separate facilities for cyclists have been more commonly developed in places where automobiles cannot go—in stream and river valleys, parks, and along abandoned rail lines. Education and encouragement have been more prominent in many bicycle programs in these countries, complemented by efforts to make roadways more compatible for the mixing of cyclists and motorized traffic.

Whether the low level of walking and cycling trips in these countries is the cause or effect of these policies is subject to much argument. Indeed, in all these countries, both critics and proponents of highway-oriented transportation planning and policies can be found.

In Australia and New Zealand, as in the United States, there is growing attention to the needs of pedestrians and cyclists for interconnected networks of pedestrian and bicycle-friendly streets. Political support for such objectives is growing due to converging concerns of many citizens, environmentalists, pedestrians, and political leaders who are adopting new attitudes towards the automobile. The utilitarian potential of cycling is being increasingly recognized as environmental, energy, congestion, global warming, and pedestrian safety concerns receive growing attention from policymakers. As these interests converge, traffic-calming strategies from Europe and Japan appear to be gaining ground, along with increasing pressure for rethinking automobile-dependent land use and urban design patterns. Together, these moves promise to expand the opportunities and space available for people to make short walking and cycling trips in their communities, even for those less skilled at dealing with traffic.

A report on bicycle and pedestrian programs and policies in Asia encompasses a vast subject. Because this report is intended to help offer guidance to rapidly changing U.S. transportation policies and programs, its focus is directed mostly towards the affluent countries of Japan, Australia, and New Zealand, where the lessons most potentially transferable to the U.S. context are found.* As a brief synthesis, this report must by necessity overlook many important and interesting facts and elements that could conceivably be encompassed by its broad title. Hopefully, this effort will promote greater interest among U.S. transportation planners and policy makers about the Asian, Australian, and New Zealand transportation experience.

Especially in transportation and land use policy and planning, there is a wealth of knowledge to be obtained by studying the different paths taken by other cultures and societies. Despite differences in cultural, economic, and political structures, many transportation and land use strategies do have potential for transferability between the more affluent societies of Asia and the United States.

The many serious challenges facing the United States in implementing the Clean Air Act Amendments of 1990 and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) make a renewed interest in the Asian and European transportation strategies timely. New

* More information on bicycle policies and use in the low-income countries of Asia can be found in the report, by Michael Replogle, *Nonmotorized Vehicles in Asian Cities*, World Bank Technical Paper No. 162, Asia Technical Department Series, Washington, DC, 1992.

directions for policy and programs are emerging at the Federal, State, and local levels across much of the United States. Hopefully, this report will help a wider audience draw on the rich experience of America's major trading partners in the Pacific basin.

II. Extent of Bicycle and Pedestrian Travel

Mode Share

Walking and cycling account for a very large share of all trips in many cities across Asia, including Japan, but for a far smaller share in Australia and New Zealand. The share of trips in Asian cities accounted for by nonmotorized transportation (NMT) modes ranges as high as 90 percent and as low as perhaps 10 percent. The share of vehicular traffic composed of nonmotorized vehicles (NMVs) ranges as high as 80 percent to as low as 1 percent or less.

This substantial variation is a function of many factors, including topography, metropolitan structure, level of motorization, climate, and historic and current transport and land use policies. It should be noted that in the highest income country in the region, Japan, walking and cycling account for more trips than automobiles, in sharp contrast to the United States, where roughly nine out of 10 trips are by car. As table 1 shows, walking and cycling are used for 45 percent of trips in metropolitan Tokyo and for more than 50 percent of all trips in many smaller cities in Japan. This high dependence on nonmotorized modes for short trips contributes to heavy use of the high-quality rail transit system for longer trips. The result is that residents of Tokyo have been estimated to use seven times less gasoline per capita than residents of large U.S. cities.[1]

As table 2 shows, there is a dramatic contrast between Japanese and Australian cities in the share of trips made by walking and cycling. In 1950, one out of 10 work trips in Melbourne was by bicycle; by the 1980s this had fallen to one out of 50 work trips. In Japanese cities, however, there was only a small decline in the share of trips by walking and cycling between 1968 and 1988. While the available data do not in most cases separately break out walking trips from cycling trips, the walk share has accounted for most of this reduction in nonmotorized travel. In many Chinese cities, where public transportation is not so well developed as in Japan, bicycles account for an even larger share of all trips, ranging as high as 65 percent of all trips in Shenyang. The changes in the use of bicycles for commuting in New Zealand are shown in table 3, revealing that there was significant growth in cycling in the late 1970s and modest growth since then. Unfortunately, mode share data including pedestrian trips are unavailable for New Zealand and a large share of cities throughout the region of this study.

High levels of walking and cycling occur in both very high income and large cities, and in low income and small cities. High levels of cycling occur in cold and snowy climates, as well as hot and rainy climates. Income, city size, level of motorization, and climate, while significant

Table 1. Share of Total Person Trips by Various Modes for Selected Cities

City	*Year*	*Walk*	*Bicycle & NMV*	*Bus & Rail*	*Motor-cycle*	*Auto-mobile*	*Other*	*Total*
Kanpur, India	1977	72	24	0	3	1	0	100
Tianjin, China	1987	50	41	9	0	0	0	100
Shenyang, China	1984	10	65	25	0	0	0	100
Shanghai, China	1986	38	33	26	..	3	..	100
Kathmandu, Nepal	1987	56	8	16	14		6	100
Ahmedabad, India	1981	43	20	29	6	1	1	100
Bangalore, India	1984	44	12	36	6	2	0	100
Bandung, Indonesia	1976	40	16	46				100
Surabaya, Indonesia	1984	20	25	13	26	9	7	100
Delhi, India	1981	29	18	40	13			100
Tokyo, Japan[1]	1988	45		28	**	27	0	100
Okayama, Japan[2]	1982	23	30	7	**	39	1	100
Matsuyama, Japan[2]	1982	27	23	12	**	34	4	100
Jakarta, Indonesia	1984	23	17	25	13	8	14	100
Bombay, India	1981	15	11	58	1	8	7	100
Melbourne, Australia[3]	1979	19	2	13	..	64	2	100

Sources: Unless noted, Michael Replogle, *Nonmotorized Vehicles in Asian Cities,* World Bank, 1991, citing various sources. (1) *Movement of People in the Tokyo Urban Region,* Tokyo Urban Regional Traffic Planning Board (in Japanese), cited in Kazuo Uchida, "Current Issues in Tokyo Regional Transport Planning," *The Wheel Extended,* No. 77, Toyota Motor Corporation, Tokyo, Japan, p. 4. (2) *The Research Report on Strengthening the Bicycle Network Function* (in Japanese), Japan Bicycle Road Association, 1988, Tokyo, p. 2. (3) *Traffic in Melbourne Study: State of the System,* Vic Roads, Melbourne, Australia, November 1990, p. 2.
Notes: ** small amount included with bike/NMV category; .. data not available or included in other categories.

Table 2. Person Trip Mode Shares for Selected Cities and Trip Purposes

City/Country	Purpose	Year	Walk	Bike/ NMV	Bus	Rail	Motor- cycle	Auto- mobile	Other	Total
Australia[1]	Work Trips	1986	6.0	1.6	..	..	..	..	98.4	100
—Adelaide[1]	Work Trips	1986	3.0	2.2	..	..	..	..	97.8	100
—Canberra[1]	Work Trips	1986	3.6	2.0	..	..	..	..	98.0	100
—Melbourne[1]	Work Trips	1950	..	10.0	..	..	..	..	90.0	100
		1976	..	1.0	..	..	..	..	99.0	100
		1981	5.8	1.8	4.1	12.0	1.0	74.7	0.6	100
		1986	5.3	1.7	3.5	11.2	0.9	76.1	0.5	100
Japan [2]	Commuting	1980	..	15.0	..	..	..	..	85.0	100
—Tokyo [3]	Commuting	1968	25.8		9.4	51.9	*	12.9	0.0	100
		1978	23.1		4.7	47.2	*	25.0	0.0	100
		1988	21.7		2.9	46.0	*	29.4	0.0	100
	Personal Activity	1968	69.0		6.9	12.9	*	11.1	0.1	100
		1978	62.3		4.8	13.3	*	19.6	0.0	100
		1988	57.9		3.4	13.3	*	25.4	0.0	100
	Business Travel	1968	25.8		3.3	13.7	*	56.0	1.2	100
		1978	19.8		1.3	13.3	*	65.1	0.5	100
		1988	16.8		1.1	17.9	*	63.9	0.3	100
—Okayama[4]	Commuting	1982	6.1	28.4	6.4	4.7	*	**53.9	0.5	100
—Matsuyama[4]	Commuting	1979	12.7	28.6	10.1	6.1	*	**41.5	1.0	100

Sources: (1) *Traffic in Melbourne: State of the System,* Vic Roads, Melbourne, Australia, November 1990, p. 2; Alan A. Parker, "The Future of Nonmotorized Passenger Transport in Australian Capital Cities," 1989 National Transport Conference, Melbourne 23 May 1989; (2) Japan National Census of 1980, cited in H. Koike, "Current Issues and Problems of Bicycle Transport in Japan," *Transportation Research Record No. 1294,* Washington, DC, 1991, p. 40. (3) Tokyo Urban Region Traffic Planning Commission, *Human Movement in the Tokyo Urban Region: From the Third Person-Trip Survey* (in Japanese), p. 11, cited in Tadashi Murao, "Reforming Transportation in the Megalopolis: Focus on Japanese Cities," *The Wheel Extended,* No. 78, Toyota Motor Corporation, Tokyo, December 1991. p. 14. (4) The Research Report on Strengthening the Bicycle Network Function (in Japanese), Japan Bicycle Road Association, 1988, Tokyo, p. 2.

Notes: * small share is included in walk/NMV total; ** includes goods vehicles; .. indicates missing data.

Table 3. Increase in Bicycle Use for Commuting in New Zealand 1976-86

Area	Number Cycling to Work			Proportion of Work Force Cycling to Work	
	1976	1981	1986	1981	1986
Total New Zealand	38,030	62,367	78,429	4.7	5.2
Main Urban Areas (>30,000 population)	26,445	45,804	55,557	5.0	5.4
— Christchurch	9,335	13,020	14,007	10.7	10.5
— Auckland	2,846	7,149	9,549	2.1	2.4
— Wellington	1,346	2,742	3,399	1.8	3.2
Secondary Urban Areas (>10,000 population)	..	6,519	9,075	7.6	9.5
Minor Urban Areas (>1,000 population)	..	7,023	9,843	6.4	7.6
Rural Areas	..	3,021	4,032	1.4	1.7

Sources: National Roads Board, Urban Transport Council, *Guide to Cycle Facilities,* August 1985, Wellington, NZ, and *1986 New Zealand Census of Population and Dwellings,* Series C, Report 5, Table 10.

within many societies in explaining variation in walking and cycling, appear inadequate to explain this variation between societies in which widely varying transport and land use policies are found. This report seeks to briefly examine, based on available literature, the extent to which bicycle and pedestrian programs and other factors influence this variation.

Vehicle Ownership

Bicycles are the predominant type of private vehicle in many Asian cities. Bicycle ownership in Asia is now more than 400 million and growing rapidly, as table 4 shows. Very high bicycle ownership rates are found in the most affluent countries and more highly motorized countries, such as Japan, as well as in some of the lowest income and least motorized countries, such as China.

The largest share of bicycles are in China, where bicycle ownership increased more than 50-fold between 1952 and 1985, to 170 million.[2] Since then it has risen to 300 million and is anticipated to grow to 500 million by 2000.[3] In many Chinese cities, bicycle ownership rates are one bicycle per household or more. Between 1980 and 1988, the number of bicycles in Beijing grew more than 12 percent a year to 7.3 million. Bicycle ownership is also growing rapidly in India, where in 1985, there were roughly 25 times as many bicycles as motor vehicles. Although motorcycles and motorbikes threaten to displace bicycles from many Indian cities, even

Table 4. Vehicles in Selected Cities and Countries

City	Year	Bicycles (X1000)	Cycle-Rickshaws (X1000)	Motor Vehicles (X1000)	Population	Bicycles per 1,000 Residents	Motor Vehicles per 1,000 Residents
Low-Income Countries							
Bangladesh	1982	1,500	633	250	na	na	na
China	1988	300,000	500	1,200	1,104,000	272	1
India	1985	45,000	1,700	1,500	765,000	59	2
Indonesia	1985	na	200	na	na	100	na
Middle-Income Countries							
Korea, Rep. of	1982	6,000	na	na	39,000	154	20
Thailand	1982	2,500	15	400	49,000	51	53
Malaysia	1982	2,500	na	900	14,000	179	64
High-Income Countries							
Australia	1988	6,800	na	7,100	16,200	420	440
Japan	1988	60,000	na	30,700	122,000	492	252
New Zealand		na	na	na	na	na	na
Netherlands	1985	11,000	na	4,900	14,000	786	350
United States	1988	103,000	na	139,000	245,000	420	567

Sources: 1982 China data from Zihao, Wang, 1989, op.cit.; Tianjin data from Thornhill, William, "Nonmotorized Transport in Tianjin, China, presented at Transportation Research Board Annual Meeting, 1991, Washington, DC; 1980/88 Shanghai data from Shenghong, Chen, "Major Issues in Transport Planning of Shanghai," *China City Planning Review*, September 1990, pp. 17-26; India data from Pendakur, V.S., 1986, op.cit., p. 31. and Maunder, D.A.C., "Comparison of Cycle Use in Delhi, Jaipur, and Hyderabad," TRRL, Crowthorne, U.K., 1980; Indonesia data from Soegijoko & Cusset, "Mobility and Transport Perception in Some Medium Sized Cities of Java," 1988, cited in Sugijoko, Budhy Tjahjati S. and Horthy, Sharif, "The Role of Nonmotorized Transport Modes in Indonesian Cities," *Transportation Research Record*, 1991 (forthcoming) and Gallagher, Rob, *The Rickshaws of Bangladesh*, 1989, Chapter 6, p. 69. Country data from: Lowe, Marcia, Worldwatch Institute Paper 90, and United Nations, *Bicycles and Components: A Pilot Survey of Opportunities for Trade Among Developing Countries*, Geneva, International Trade Center UNCTAD/GATT, 1985 or later.

these less expensive motor vehicles are beyond the financial reach of the majority of the Indian population, who aspire more realistically to bicycle ownership.

Bicycle ownership in the affluent countries of the region is also quite high. The per capita bicycle ownership of 0.42 in Australia equals that of the United States, and amounts to some 6.8 million bicycles. Bicycle sales have frequently exceeded new motor vehicle registrations in Australia since the early 1980s and have been growing at a rate of 8 percent a year in recent years. More than half of Australian households own at least one bicycle, with one-third of households owning two or more.[4] While hard data for New Zealand are not available, bicycle ownership levels there appear to be comparable.

Only the United States and China exceed Japan in the number of bicycles. Ownership of bicycles in Japan grew by more than 4 percent a year during the economic boom of the 1980s, reaching 70 million by 1990. This is double the number of motor vehicles and represents 1.7 bicycles per household and one bicycle for every 1.8 residents.

Middle-income Asian countries generally have lower, although still considerable, bicycle ownership levels, reflecting their trend towards rapid motorization, which in many cases means motorcycles and scooters. South Koreans, for example, own more than 6 million bicycles, or one bicycle for every six residents.

The majority of the world's 3.3 million cycle-rickshaws and goods tricycles are found in Asia. These are concentrated in the lower-income countries of the region, particularly Bangladesh, India, China, and Indonesia. However, even in the high-income country of the region, Japan and the Republic of Korea, there are an estimated 15,000 cycle-rickshaws in use for goods movement. While a large share of these are used for short distance urban delivery and street vendors, cycle-rickshaws for goods movement are also employed in modern Japanese factories and manufacturing complexes, as in the United States.

Despite recurrent efforts made by some local authorities in Indonesia, India, and Bangladesh to suppress cycle-rickshaws in preference to motorized transport modes, the number and use of these vehicles is growing in many cities in response to otherwise unmet transport needs. The Indian Planning Commission in 1979 estimated that the number of cycle-rickshaws in India would increase from 1.3 million in 1979 to 2.2 million by 2001. Similar increases are forecast for Bangladesh.

Influence of Social Class and Income

Income has a significant effect on vehicle ownership levels and job and housing location. However, it is impossible to generalize about the effects of income on walking and cycling across the diverse region of Asia, Australia, and New Zealand. The effect of income on walking and cycling varies depending on a number of factors.

In low-income countries, those with low incomes have little choice but to walk or ride bicycles for many of their trips. Despite rising incomes in many cities across Asia, the distribution of wealth and income remains skewed in much of the region. Rapid urbanization and economic growth throughout much of Asia has left behind hundreds of millions of people, who continue to live in desperate poverty. Two-thirds of the poorest of the poor in the world live in India, Bangladesh, Pakistan, and China.

Many of these low-income people in Asian cities cannot afford even subsidized public transport fares and have no choice but to walk or cycle, even for travel distances of 10 to 20 km (6 to 12 miles). For most poor households, walking accounts for the majority of all trips. When incomes are low, the value of time relative to cost for travelers is low as well. Although walking costs nothing but wear on shoes or feet, it takes a lot of time for all but short trips. Cycling often offers four or five times greater speed and is cheaper than public transport, once a bicycle is in hand. When a bicycle that will last years costs the equivalent of six or eight months of bus fares, there is good economic incentive for a poor person in having one and using it. Low-income households are forced to spend a higher share of their income on transportation than higher-income households, as they often have to live far away from their jobs to find cheap housing, often hold multiple part-time jobs, and, since their income is small, a single bus fare may represent a large share of their earnings. The poor in general make fewer trips than higher-income people and engage in little discretionary travel.

Thus, for the poor in the lower-income countries of Asia, increases in personal mobility are most commonly expressed in expanded use of bicycles. Increased mobility for goods movement and the transport of children and families is often expressed in greater use of cycle-rickshaws, where these are available, or bus public transportation where this is available. Irrespective of city size, the poor will continue for the foreseeable future to be dependent on nonmotorized transport modes for mobility in Asian cities.

As incomes rise further in these low- and middle-income countries, the trend is towards acquisition of motorcycles and motorscooters. Bicycles have become identified as a mode for the poor, and middle-class families, while often owning one or more bicycles, prefer motorbikes for commuting and as a display of their higher status. Only at the very highest income levels can households afford automobiles, which remain beyond the reach of all but a small minority of the population in low- and middle-income Asia.

However, in a number of lower-income countries, such as China, bicycles have become the mode of choice for travel by both the working class and emergent middle class. This situation is a product of conscious Government policies, which have favored bicycle transportation development as a way of ensuring mobility while restraining expensive expansion of public transportation capacity. Employer and Government subsidies to bicycle commuters, preferential allocation of street space to cyclists, and lagging investment in public transportation have fostered strong dependence on the bicycle, just as similar policies favoring the automobile in the United States have fostered automobile dependence. Bicycles are faster than buses for many commuting trips of even 10–15 km (6–10 miles) length, and offer the opportunity to run errands to and from work, serving the same function as the automobile in America.

In the highest income countries of Asia, however, it is not only the poor who use bicycles. The travel time and convenience offered by the bicycle attract people of all income levels to bicycles in many cities, particularly where measures have been taken to facilitate cycling, such as in Japanese cities.

In one of the world's most affluent societies, Japan, 82 percent of households own at least one bicycle and the average household owns 1.45 bicycles. In a survey in the late 1980s that asked for the primary reasons Japanese households used bicycles, 86 percent reported their use was for shopping and local errands, and 34 percent for work and school commuting (including access to rail stations). Only 28 percent reported using bicycles for leisure, in sharp contrast to America, where recreation is the dominant use of bicycles.[5] Comparing these responses with the results of the same survey from a few years earlier indicates, however, that recreational use is growing, while commuting use is declining somewhat.[6]

Surveys of cyclists in Matsuyama and Okayama, two mid-sized Japanese cities, found that in 1987, a fourth to a third of cyclists were workers, a fifth to a third were students, and nearly one-third were housewives. Only about one in 20 were self-employed, and an equal number were unemployed.[7]

The largest share of Japanese bicycle users for shopping trips are women, who typically ride bicycles to local shops one or several times a day using low-cost minicycles, with 20-inch wheels, light frames, made for easy handling, and carrying baskets. Bicycle commuters in Japan can be divided into several predominant groups. Those who ride a bicycle directly from home to work or school tend to be either lower- and middle-income blue-collar industrial workers who live close to their factories or students riding to school. Those who ride a bicycle from home to rail station or from rail station to work or school tend to be middle- or high-income "salarymen" or students, who live in often far distant suburbs. The longest portion of their commute trip is by train, with the bicycle playing an access or egress function. Thus, while bicycle use in Japan cuts across most social and economic classes, the character of bicycle use varies depending on sex and socioeconomic status.

In middle- and high-income motor vehicle-dependent cities where less provision has been made for bicycle transportation, the lower frequency of bicycle use tends to be divided between two predominant but disparate user groups—low- and moderate-income people, including many of the unemployed and the young, who use the bicycle for utilitarian transportation, and higher-income people, who use the bicycle mostly for sport and recreation. This is largely the case in Australia and New Zealand. A large survey of cyclists over the age of 12 years in Melbourne found that two-thirds rode for leisure, 37 percent rode to visit friends, 31 percent for shopping trips, 11 percent to get to work and 6 percent to get to the railway station, although the highest frequency cycling trips were for commuting to work and universities.[8]

In New Zealand, the largest group of cyclists is schoolchildren, especially in the 10–14 year old age group. A survey in 1977 showed that about three-fourths of this age group used bicycles. Commuters were estimated at that time to comprise "a growing and somewhat neglected group" accounting for about 10 percent of total commuter traffic. Shoppers in the suburbs were another group with notable levels of bicycle use.[9] A 1977 morning peak hour cordon traffic count around the central area of Christchurch, a city of 300,000, showed that 9.7 percent of all people crossing the cordon were cyclists, about half of them cyclists riding to schools. The highest cyclist volumes were on the lower-traffic volume streets.[10] In several

New Zealand cities, bicycles accounted for a significant share of work trips in 1981—Gisbourne (13.8 percent), Palmerston North (13.3 percent), and Christchurch (10.7 percent)—but in the largest cities of Wellington and Auckland, work trip bicycle mode shares were only about 2 percent.[11]

Just as bicycle trip purpose varies between countries and cities, so too do the typical lengths of bicycle trips. Longer average bicycle trip lengths are observed especially in larger cities of many lower income countries where public transportation is inadequate, compared to high income countries. However, as figure 1 shows, Japanese cyclists use the bicycle for a large share of trips even at trip lengths of 6 km (4 miles). Although these 1975 data are the most recent readily available, these relationships appear to be relatively unchanged today.

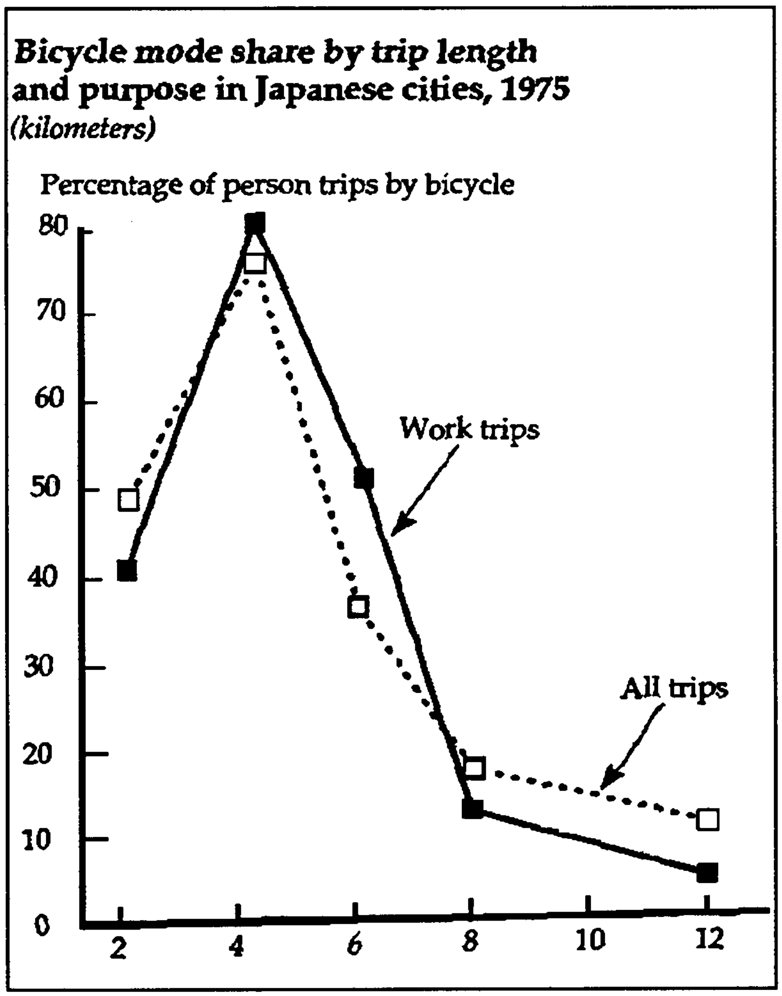


Figure 1. Share of Trips Made by Bicycle by Trip Length and Purpose, 1975, Japan

Influence of Climate

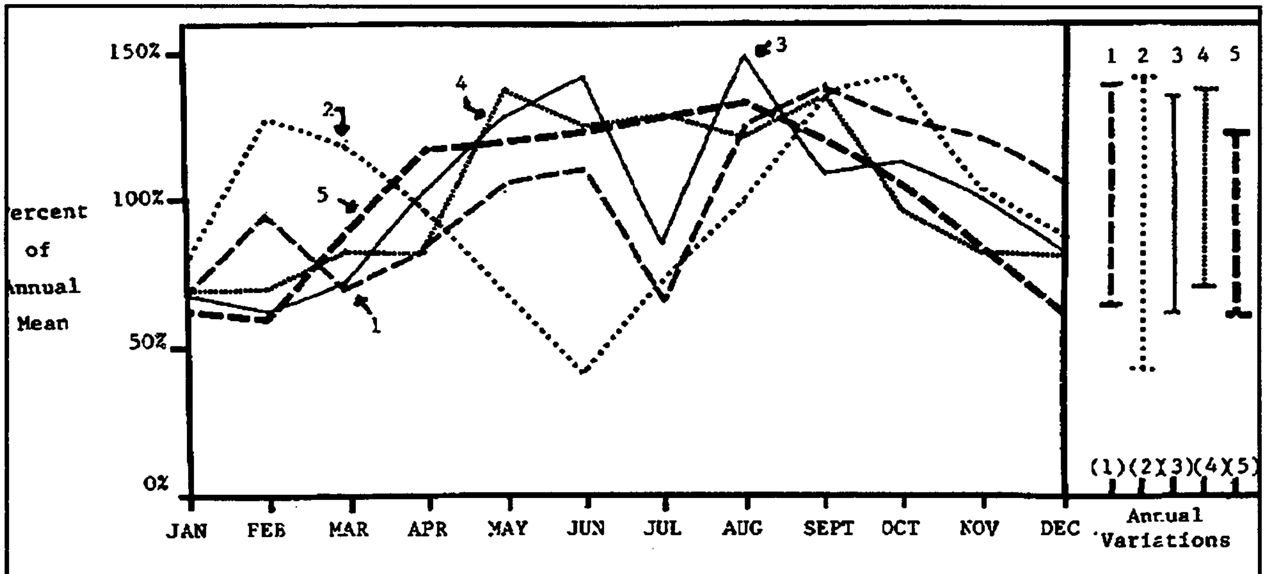
Substantial variation in bicycle use and walking around the world can be explained in part by differences in climate, but the effect is significant generally only within a particular society in which transportation and land use policies have conditioned the use or disuse of walking and bicycles and shaped attitudes towards cycling or walking in unpleasant weather.

Data on seasonal variations in walking trips are not readily available. However, it is clear that in many cities with cold and wet winters, the level of walking and cycling remains very high even in the least hospitable months of the year. For example, as Figures 2 and 3 show, the level of bicycle use for commuting trips to work and school remains at one-fourth to one-fifth of all trips in February in many communities in Japan where snowfall annually exceeds 10 to 15 cm (4–6 inches), although it is lowest in the very cold, snowy, mountainous northern island of Hokaido. The use of bicycles for access to railway stations in Japan declines only by 10 to 20 percent in the winter, compared to summer. This is similar to the experience of cold and snowy Finland, where winter bicycle use is still at about 60 percent of the mean level of use, and where bicycles accounted for 17 percent of all trips in 1980.[12]

Little seasonal travel demand data for nonmotorized modes are available for Asia, Australia, or elsewhere. However, figure 4 shows the variations in bicycle use for a number of areas around the world. Seasonal variations in bicycle use tend to fluctuate from about 140 percent to 60 percent of the annual mean in many temperate climate areas with significant bicycle travel. However, seasonal differences in societal activity patterns—such as holiday periods—often have more effect on cycling than weather conditions themselves. In Hamburg, Germany, for example, bicycle use of access to rail stations drops during summer holiday periods to levels lower than winter patronage. In Santa Barbara, California, school schedules accounted for most of the monthly ridership variation on bike-on-bus services. Comparing the number of bicycles parked as Danish railway stations in January and August shows only a 16 percent drop from winter to summer, despite heavy seasonal snowfall.[13]

Walking and cycling similarly are year-round phenomena in many tropical countries with extremes of climate, such as India and Southeast Asia. Extreme heat and humidity can make bicycling and walking uncomfortable, but these often remain more comfortable than riding a bus, which is the usual alternative to nonmotorized travel. Very few air-conditioned motor vehicles are available in the majority of tropical countries.

The widespread adoption of 10–speed bicycles with narrow tires and brakes that perform poorly in wet conditions by American cyclists in the 1970s diminished the potential for year-round cycling in most U.S. cities. In contrast, European and Japanese commuter bicycles are more commonly equipped with wide tires, which handle better in snow, and rear drum brakes, which are more efficient in rain. The 1980s, however, brought the widespread acceptance by



(1) Number of parked bicycles at Hamburg, F.R.G., rail stations (4/81-3/82)
(2) Number of bicycles carried on Santa Barbara, California, bicycle-bus trailers (6/79-4/80)
(3) Bicycle traffic counts in seven areas near Copenhagen, Denmark (late 1970s)
(4) Nationwide bicycle traffic counts, Denmark (1960-1978)
(5) Nationwide bicycle traffic counts, Finland (1974).

Figure 2. Seasonal Variations in Bicycle Use for Selected Areas in Finland, Denmark, Germany, California

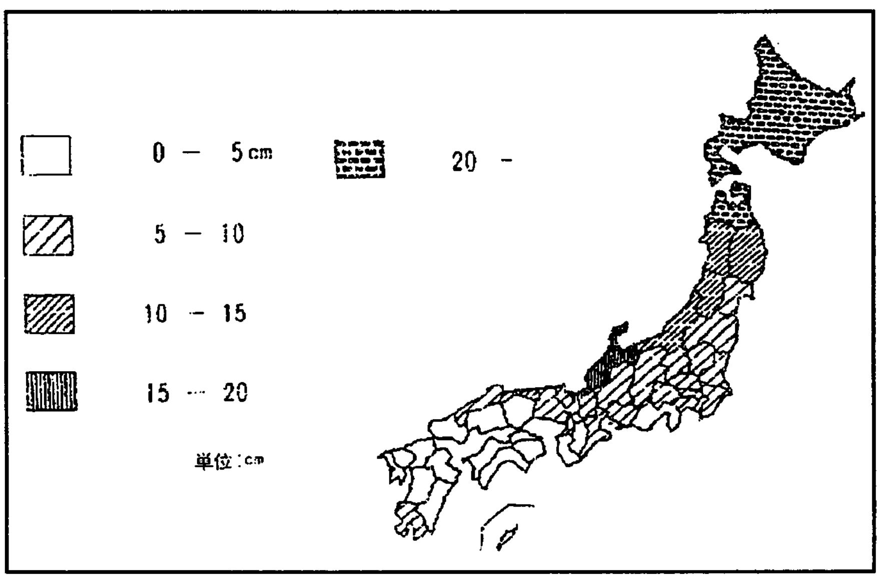


Figure 3. Depth of Average Annual Snowfall in Japan

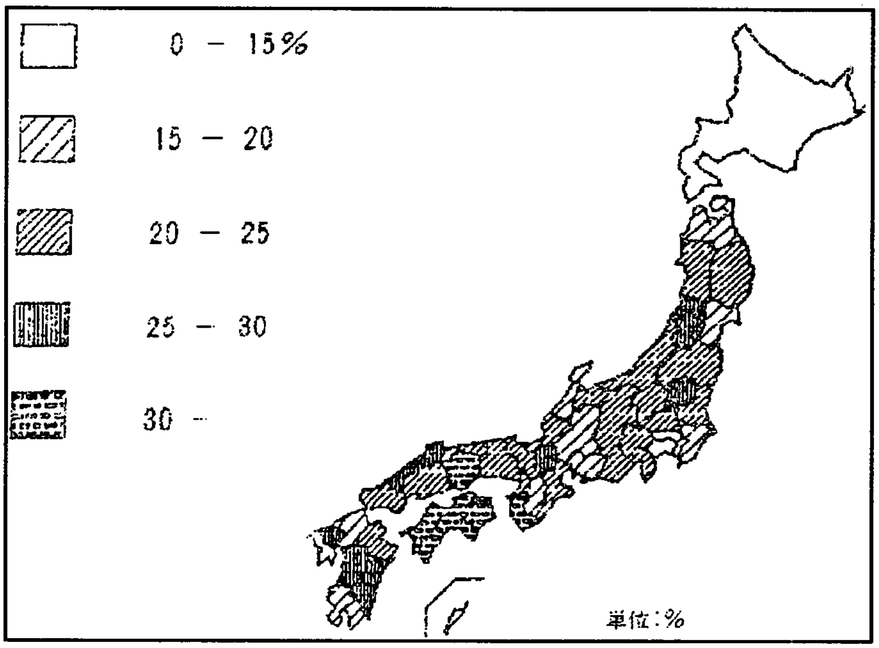


Figure 4. Percent of Work and School Trips by Bicycle, February 1981

adult American cyclists of all-terrain, mountain, and city bikes, which more closely resemble the performance characteristics of European and Japanese commuter bicycles than 10-speed racing bicycles. This has facilitated the growth of inclement weather cycling in the 1990s in the United States.

Cultural attitudes have a major role to play in influencing seasonal variations in bicycle use and walking. In Japan and much of Europe, there is little stigma attached to entering an office dressed appropriately for cycling or walking in wet weather. In many U.S. communities, in contrast, the very behavior of walking or cycling in rain or very cold weather may be regarded as somewhat eccentric and prompt comment from strangers and associates alike. Indeed, a large share of Americans do not know how to dress properly for cycling in poor weather and have misconceptions about the level of discomfort involved.

Many factors influence use of bicycles and walking, but climate, income, and the level of motorization cannot explain the wide variation between countries. How these modes are perceived socially, how safe people feel riding a bicycle or walking, and the character of street and urban design all appear to be more important factors in accounting for variations in use.

III. Evolution of Bicycle and Pedestrian Modes in the Region

The use of different transportation modes is very much a function of historic forces that constrain or facilitate the development of transportation systems, travel behavior habits, and land use patterns. Thus, a brief review of the history of transportation system evolution in the region that is the subject of this study may be helpful in understanding how these different societies have attained their current transportation conditions for bicycle and pedestrian travel.

Japan

Bicycles made their first appearance in Japan at the turn of this century and achieved at least a moderate level of use before the Second World War. The destruction caused by mass bombing in the closing years of that war left transit and highways badly damaged. As a result, bicycles and walking played an important role in Japanese urban mobility in the 1940s.

By the 1950s, the Japanese urban railway system had been reconstructed and formed the basis for land development and economic growth. Because of the dense network coverage of urban railways, the limited availability of land for the competing activities of agriculture and urban development, strong land use controls, and a low level of motorization, the vast majority of the metropolitan population in Japan resided and worked within walking distance of rail stations. The bicycle fell into disuse as an unpopular reminder of the lean postwar reconstruction years while public transportation use grew.

Due to land use controls, tax policy, and scarcity of usable land in Japan, land costs in central areas have been extremely high. Increased affluence, high land costs, and Government policies favoring the development of satellite cities have led to substantial growth in suburban areas since the mid-1960s. Although employment continues to be concentrated in central areas, since 1970, the fastest rate of employment growth has been in these suburban satellite cities, mostly focused around rail stations.

Due to many factors, the Japanese continue to rely heavily on public transportation. Continued expansion of high-speed rail lines into suburban areas, scarce and expensive automobile parking in city and town centers, high automobile ownership and operating costs, and employer subsidies for employee transit commuting have all contributed to substantial transit use. Largely as a result of high land costs near urban centers and employer transit fare subsidies, the typical Japanese worker commutes 20 to 40 km (12 to 25 miles) each way by railway to get to work.

The heavy dependence on public transportation results naturally in a substantial share of trips made by foot. Suburbanization and rapidly rising motor vehicle ownership in the 1970s and 1980s have caused a small reduction in the share of trips made by public transportation and walking, while bicycle use has grown, particularly for access to suburban rail transportation.

Between 1968 and 1988, the share of total person work trips made in the Tokyo region by railway declined from 52 percent to 46 percent, and walking and bicycle trips together declined from 26 to 22 percent, despite a very large increase in automobile ownership and suburbanization. The share of all trips made by railways has remained relatively stable at about one-fourth, even in distant suburban areas in the Tokyo region over the past several decades, with ridership increasing due to the growth of suburban travel demand.

With such a heavy reliance on rail transportation, access trips to rail stations make up a significant component of all Japanese travel. Walking is the predominant access mode for nearly all rail stations within metropolitan areas, although bicycles account for a major share in suburbs and outer ring areas. Because suburban communities tend to be built in a dense nodal fashion, with declining intensity of land use as the distance from rail stations increases, pedestrian access to rail is feasible for a large share of rail passengers, even in suburbs 40 or 50 km (25 or 30 miles) from the primary central cities.

The dense development around rail stations in distant suburbs is largely a function of Japanese growth management policies. However, expensive land near stations, rising automobile ownership, and the desire for cheaper housing have prompted extensive real estate development in areas well beyond walking distance of rail stations and a dramatic transformation of suburban transit access.

Until the late 1960s, few Japanese railway stations had designated areas for bicycle parking. Due to a very low crime rate, individuals who used bicycles to reach the stations could park their bicycles near station entrances without supervision, authorization, or secure locks. By the early 1970s, bicycles began to accumulate in growing numbers around stations and shopping areas, due to a combination of factors. The environmental movement began to alter attitudes towards the bicycle as memories of the postwar reconstruction period faded. The growing number of people living beyond walking distance of rail stations found that too often, crowded collector bus services forced them to wait too long and to pay extra fares, while often delivering slow access speed in congested areas near the stations. The introduction of the minicycle, with 20-inch wheels, light frames, easy handling, and low cost, appealed to many adults. In the early 1970s, bicycle ownership was growing by more than 10 percent a year. [14]

Soon, the demand for bicycle parking in station squares outstripped designated capacity. With low bicycle theft rates, people began crowding their bicycles into any open space near stations, leading to what the authorities branded "bicycle pollution." This prompted debate in the Japanese Diet and passage of a new law in 1977 that created more than 730,000 bicycle parking spaces at rail stations by 1981, and more than 1.5 million additional spaces in the 1980s.

Growing environmental concerns also led to Government support for creation of bicycle-pedestrian paths and bicycle lanes, which grew from almost nothing in 1970 to over 60,000 km (37,000 miles) by 1990. These investment programs have generally favored the separation of bicycle and pedestrian traffic from automobiles, rather than the integration of bicycles into traffic, as in the United States and Australia. However, in the 1980s, Japanese authorities also began to support traffic-calming measures to slow down car traffic in residential and commercial districts to improve safety and promote walking and cycling through greater integration of slow and fast modes on low-traffic-volume streets. With the Japanese Government's commitment to further reduce Japan's already relatively low per capita CO_2 emissions to help stem global climate change, further actions to promote walking and cycling are likely in the 1990s.

Thus, in the span of several decades, the bicycle rose, fell, and then dramatically rose again as a significant mode of transport. It was transformed from being seen as a valued and practical low-cost vehicle, to being seen as a low-status mode for the poor, and then found new social value as the practical vehicle for daily shopping and trips by white-collar suburban "salarymen" headed to catch the train to their middle- and upper-middle class jobs in major cities.

Japanese transportation policies and programs favoring the bicycle and the maintenance of effective land use planning played a key role in reversing the decline of the bicycle in Japan. Investment in bicycle facilities was spurred by the demand-pull for parking at rail stations, which was able to exert itself because bicycle theft did not prevent people from freely exercising a choice of how to reach station despite the absence of secure bicycle parking. Once started, the major increase in the supply of bicycle facilities has shifted this equation, enabling a supply-push that encourages continued growth in use of bicycles for access to transit and other short trip destinations. In 1991, there are over 3 million bicycles parked at railway stations across Japan every workday, and the supply of guarded bicycle parking facilities continues to grow rapidly to meet rising demand.

The growing network of bicycle lanes and efforts in traffic calming reinforce this demand and, combined with the climate of community opinion supportive of bicycling, high user fees on the automobile, and clustered mixed land use focused around public transportation, assures that bicycle transportation has a bright future in Japan.

The encouragement of bicycle use has also favored pedestrians, who have benefitted from traffic-calming measures, the provision of pedestrian streets in shopping areas near railway stations, and policies that make the use of automobiles, especially in cities, very expensive and often inconvenient. For example, typical automobile registration fees in Japan amount to US $2,000 per car every 2 years; owners of automobiles in large cities such as Tokyo must prove they own or rent a parking space before they can register their car in the city; parking violations may result in fines of US $1,500 or more; gasqline prices are 3.1 times higher than in the U.S.;

and the typical toll for a 100-km (60-mile) trip between cities on an expressway is US $20 for an automobile and $55 for buses and large trucks, despite frequent severe traffic congestion and delay. Such policies, when combined with a very high quality railway system that serves most development centers and relatively pedestrian and bicycle friendly cities, have had a major influence on automobile ownership and use. Although automobile ownership has risen significantly with the growing affluence of the past two decades and Japan now exceeds the United States in per capita income, dependence on the automobile remains relatively low. Residents of Japanese cities use roughly one-tenth as much gasoline per capita as residents of U.S. cities, largely as a result of the combination of these policies and the land use patterns they have fostered.[15]

Australia

Bicycles were introduced into Australia in the latter part of the 19th century. As in the United States, bicycle clubs were formed in the 1880s and 1890s to promote this mode, which attained the height of popularity by the end of the century. However, by the end of the first world war, automobiles began to displace bicycle use. By 1923, Australia ranked sixth in the world in terms of the absolute number of motor vehicles, with 115,000 cars, 42,000 motorcycles, and 12,000 commercial motor vehicles. By 1930, only the United States and New Zealand had higher per capita car ownership than Australia, where there was one automobile for every 10.7 persons.[16] By May 1925, a 2-day traffic count in one urban area found 5,511 bicycles and 2,573 motorcycles and cars.[17] As motor vehicle traffic grew, it displaced bicycles more and more, as is now occurring in countries such as India and Indonesia. By the 1930s, the principal roads had become less than pleasant for bicycle riding.[18]

By 1950, the use of bicycles for commuting had fallen to about 10 percent, and would continue to decline to fewer than 2 percent of work trips in the early 1970s, when the fuel crisis and environmental concerns arrested this trend. Between 1974 and 1984, there was a sevenfold increase in the number of bicycles in Australia.[19] However, poorly designed bicycle paths built in the early 1970s and bicycle-hostile roads built through much of the 20th century created a cycling environment poorly suited to sustain the growth in cycling that has occurred since 1973.

Geelong, a city of about 120,000 in Victoria, Australia, broke new ground in 1977 with a bike plan that focused on strategies to deal with this problem in a more comprehensive framework than most previous bicycle planning studies. This plan recognized the importance of both modifying the physical traffic system to better integrate bicycles into traffic, as well as modifying the behavior of bicycle and motor vehicle users. It was built on a number of key assumptions and findings that differ significantly in several respects from the Japanese approach to bicycle traffic, which places greater emphasis on separation of bicycles from the automobile. The Geelong concepts have been summarized as follows:

- Every street is a bicycle street.
- School bicycle paths alone cannot significantly reduce the accident problem.
- Cyclists use and favor main roads, which are direct, smooth, have priority intersections, and serve the most destination land use.
- Cyclist error causes 71 percent of bicycle/car accidents.
- Accidents occur everywhere.
- Complete off-road bikeway networks are not practicable in existing urban areas.
- A bicycle lane is not needed where there is sufficient road width.
- The signed bicycle route rarely serves a useful function.[20]

The Geelong Bike Plan represented a notable effort to support bicycle transportation seriously for the first time in Australia. However, it worked with what Japanese bicycle planners would regard as very meager resources. Indeed, the A$320,000 outlay per year made available to implement the plan over a 5-year period in the late 1970s and early 1980s was the largest commitment of funds to bicycle transportation until that time in Australia (in 1992, A$1=US$0.76). With this level of support, local planners focused 60 percent of their funding on engineering projects and physical planning, 10 percent on education, 6 percent on enforcement, 15 percent on encouragement programs, and 9 percent on administration and other activities. The Geelong Bike Plan was followed by the development of similar bicycle plans in most major Australian cities in the 1980s and the creation of State Bicycle Committees in the majority of Australian states.

While well conceived, many initiatives begun in Australian bike plans have fallen short in implementation due to weak Government support and inadequate funding. A review of the Geelong Bike Plan in 1990, for example, found that "with respect to behavioral programs after 1982, most of the impetus in the Geelong Bike Plan was lost and interest dropped... Further, there are a number of sections of the proposed '5-year plan' which are as yet uncompleted."[21] While this study found that bicycle ownership increased significantly between 1978 and 1989 and adult bicycle use had grown dramatically, by 1986, there were still only 2.6 percent of workers in Geelong commuting by bicycle.

A weak economy has fostered growing use of bicycles in Australia in recent years. While this has offered an opportunity for development of more bicycle-friendly cities and towns, those who favor bicycle transportation in Australia continue to fight an uphill battle for resources adequate to support timely implementation of bicycle plans. While the recession initially prompted public works programs to provide jobs building bicycle facilities, funding for these programs has been more recently cut.

Although bicycling is increasing in Australia from its very low share of travel observed in recent decades, walking continues to decline as a transportation mode, thanks in large part to automobile-oriented transportation and land development patterns, which make distances between activities too great for trips by foot. The share of work trips made by walking declined from 5.8 percent in 1976 to 3.8 percent in 1986 in the capital cities of Australia, while bicycle commuting nearly doubled to 1.6 percent in this period.

New Zealand

In New Zealand, bicycles were introduced in the late 19th century and by the mid-1890s had become very popular. A Cycle Traffic Bill of 1897, which never became law, recognized the growth of cycling and attempted to provide cycle facilities where they were needed. The *New Zealand Cyclist*, a magazine of the day, reported in 1897 that "The gist of the scheme is to tax cyclists, and thereby obtain funds for the alleged purpose of laying down cycle tracks on the public streets within the cycle areas... The bill, while making provision—or rather suggesting that the local authority should do so—for keeping cycle traffic apart from the ordinary vehicular traffic does not intimate very clearly how the vehicular traffic is going to be kept off the cycle track."[22]

As motor vehicles came into greater use by the affluent in the 20th century, bicycle use continued to grow, but acquired a working class stigma. In 1932, a traffic count in Christchurch, New Zealand's third largest city, found 70 percent of all traffic was bicycles. "By the late 1940s and early 1950s, Christchurch was probably as heavily cycled as any city in the world, with an estimated 80,000 bicycles in regular use."[23] In the 1950s and 1960s, "it was virtually impossible to take a car up to the stopline at many of the traffic signals in Christchurch...with cyclists occupied up to 10 meters (33 feet) of roadway back from the stopline in a great mass of cycles."[24] Bicycles were also heavily used in other parts of New Zealand.

However, increasing affluence led to rising automobile ownership and a concurrent decline in bicycle use. The low status of the bicycle became reinforced as conditions for cycling degraded in the absence of dedicated bicycle facilities. "As car numbers increased, so did the danger to cyclists. They had become, in more ways than one, a dying race. By the late 1960s, the adult cyclist was rarely seen in the center of the city, and it seemed that the age of the bicycle was over."[25]

However, as in the United States, with the 1973 oil crisis and growing traffic congestion, bicycle use stopped declining. New groups formed to promote the bicycle for environmental and health reasons. Bicycle manufacturing, which had ended in New Zealand in the mid-1950s, began again to serve a growing market. Between 1976 and 1986, the number of bicycle commuters in New Zealand more than doubled, and one in 20 work trips was made by bicycle, although the pace of growth in cycling for work trips appeared to be slowing in the mid-1980s.[26] Bicycle use remains greatest among school students in New Zealand, with 71 percent of intermediate (junior high) school students in Christchurch, for example, using bicycles to get to classes. About half of graduating high school students still depend on bicycles for school trips, but most soon shift to using cars in their early adult years.

IV. Urban Design and Traffic Management

Urban design and traffic management have a major influence on the use and safety of pedestrian and bicycle modes. In the region that is the focus of this report, there is wide variation in these factors.

Sidewalks and Pedestrian Amenities

The character of the urban streetscape has a significant influence on the quality of pedestrian travel. Sidewalks of adequate width, with street lighting, benches, resting places, weather protection, interesting shop fronts, pocket gardens, curbside trees and planting, sidewalk artists and musicians, and places to watch people all contribute to enhancing the attractiveness of walking. On the other hand, streets without sidewalks, street lighting, with excessive sidewalk clutter, litter, graffiti, crime, traffic noise and pollution, extensive blank walls or parking lots, and few places to comfortably rest all contribute to making walking an unattractive mode of travel.

The character of pedestrian amenities found in Asia, Australia, and New Zealand varies quite widely, but has not been well documented in the transportation literature, due to the general lack of attention to pedestrian concerns in many countries. In a large number of cities, especially in low and moderate income Asian countries, sidewalks are discontinuous and subject to encroachment by parked vehicles, vendors, and other obstructions. Such conditions frequently force pedestrians to walk in the street, encroaching on motorized or nonmotorized traffic and contributing to traffic congestion and safety problems.

One can find a number of communities in the region with high-quality pedestrian environments. In the late 1970s and 1980s, Singapore undertook significant streetscaping improvements, planting shade trees and installing seating along sidewalks, especially along main thoroughfares, with an objective of encouraging people to walk as far as possible and to slow down growth in motor vehicle use. However, the many wide streets of Singapore make it difficult to cross the street in many places, so that many pedestrian overpasses have had to be constructed.[27] Melbourne, Australia, although generally rather automobile dependent, has about 12,000 km (7,300 miles) of footpaths and sidewalks.[28]

In Japanese cities, pedestrian conditions compare favorably in many respects to those in other cities around the world, although a number of Japanese transport and urban planners bemoan the lack of sufficient attention to pedestrian needs. While sidewalks are far more common than in most American communities and the density of development offers a far more concentrated and interesting visual environment, there are areas where amenities are lacking. For example, a survey of amenities in commercial districts in Japanese cities in 1983 found that two-thirds had street lighting and one-fourth had special paving for pedestrians. However, arcades, guardrails, trash receptacles, and planters were each found in only one-tenth of the surveyed districts. Trees and shrubs, rest areas, public toilets, and drinking fountains were found in one in 20 or fewer of the commercial districts.[29]

Prior to the mid-1960s, there were relatively few sidewalks in Japan. Roads were narrow and there was relatively little formal separation of pedestrian, bicycle, and motor vehicle traffic. New legislation in 1966 provided substantial funding for construction of sidewalks and pedestrian overpasses and underpasses. The length of sidewalks increased steadily from about 2,000 km (1,200 miles) nationwide to some 72,824 km (44,400 miles) by 1985. Pedestrian overpasses, which numbered fewer than 1,000 in 1965 grew to 7,913 by 1975 and again to 9,781 by 1985.[30] However, many people expressed resentment over having to waste their time and energy climbing up and down steps, following an obstacle course, while automobiles followed a straight course. Moreover, overpasses were found to be useless to the elderly and disabled. In recent years, the pace of construction of overpasses has slowed to little more than a hundred a year nationwide. By 1990, there were some 10,489 overpasses for pedestrians and another 2,531 pedestrian underpasses, which have been increasing at the same rate as pedestrian overpasses since 1980.[31]

Strategies to enhance the pedestrian environment need to be tailored to local conditions. In the Live Nagaike district of Tama New Town west of Tokyo, outdoor escalators have been built on public paths in the commercial area and on the pedestrian roads connecting the rail station to residential areas that are in the hills above the station and commercial area. Shelters have also been built over the pedestrian roads, as well as at the station plaza, providing weather protection and encouraging long pedestrian trip lengths in this area, minimizing dependence on motorized modes of transport for access to the center and to transit.[32]

In recent decades, the Japanese have led the world in developing a very thorough set of tactile and auditory cues in their major cities to enable the blind to travel and find their way in relative safety. This involves a number of devices, ranging from textured mats laid into sidewalks, railway platforms, and intersections, to sound devices at traffic signals. Two kinds of guide blocks are used as tactile signs in sidewalks, stations, and at intersections to indicate routes, intersections, areas for caution, and building entrances. These are often combined with braille maps mounted in rail stations and at key intersections. Audio signals that sound melodies, chimes or bird songs to indicate when it is safe to cross streets and the direction in which it is safe to cross have now been installed at over 350 intersections in Tokyo, about 1 percent of the traffic signals in the city. Most recently, Tokyo has initiated a demonstration project to test a new system where a blind person carries a small portable transmitter. Upon reaching locations identified by guide blocks in the pavement, the user presses a button on the transmitter, prompting a recorded announcement from a speaker installed nearby that indicates in a human voice the location or an instruction.[33]

While Intelligent Vehicle Highway Systems (IVHS) are under investigation for motorized transportation in the United States, Japan, and Europe, the Japanese are seeking to apply information systems to aid pedestrians as well. Since 1990, a test has been under way in Tokyo of a system to help reduce the stress of pedestrians waiting to cross the street at major signalized intersections with more than 90-second waiting times. Illuminated stripes on the pedestrian crossing indicator signpost show the remaining time before the pedestrian signal will turn green, accompanied by an audible waiting time signal for sight-impaired pedestrians in the form of a bird warble.[34]

Pedestrian Streets and Zones

Pedestrian streets and zones have been developed in a number of cities throughout the region in response to the negative impacts of excessive traffic in city centers. By dedicating some streets to cyclists and pedestrians, local governments are able to create a far higher quality urban environment, especially in dense commercial areas, usually stimulating local businesses.

Japan has long had pedestrian-only shopping streets, or "pedestrian heavens," such as Nakamise in Tokyo's Asakusa district, Shinsai-bashi in Osaka, and Shin-Kyogoku in Kyoto. A large share of these have been in major downtown areas. A key to the success of Japanese pedestrian streets has been to permit truck access to the streets in the late night and early morning hours for delivery of merchandise. In a number of cities, selected streets are reserved for pedestrians from early afternoon to late evening, and open to all vehicles in the morning. This provides daily access for goods delivery vehicles to supply shops and allows automobile access for shoppers, while preserving a haven from traffic in other hours. With the rapid rise in automobile ownership in Japan, urban planners in Japan note the importance of providing adequate paid automobile parking at the edge of shopping streets, especially newly created ones.[35]

A notable Japanese urban planner, Kozo Amano, has noted the need for different strategies depending on the context:[36]

> *"In the case of busy downtown shopping districts, it's necessary to close the streets to create pedestrian precincts. However, for shopping streets that function as neighborhood centers inside residential areas, I think a good approach is to create* woonerf*-like 'community streets' where cars and pedestrians can mingle together. In other words, I think what's appropriate in a given situation depends on the location and the purpose."*

Australian and New Zealand cities have also developed a number of pedestrian zones, beginning in the 1970s. These have generally followed the experience of Europe and North America, although none are as large as the pedestrian zones of some European cities. Most are said to have been successful. Unfortunately, more extensive descriptions of the Australian and New Zealand experience with pedestrian zones are not readily available within the resources of this study.

Traffic Calming and Traffic Management

Japan. The Japanese are the most advanced in the region in developing traffic-calming strategies, which were first introduced from Europe in the latter part of the 1970s. Traffic calming in Japan has focused on the creation of "community streets," which are adapted from the Dutch *woonerf* concept. These are most applicable to streets where the volume of traffic can be restrained to 200 vehicles per hour or less.

A *woonerf* is a street designed to completely integrate pedestrian, bicycle, and motor vehicle traffic through traffic-calming, rather than providing separate sidewalks or sidepaths. However, Japanese traffic law is firmly based on the principle of segregating motor vehicles and pedestrians and does not recognize the idea of purposely slowing cars down. Before the initiation of community streets, in the late 1970s, the law was interpreted as requiring streets and sidewalks to be in straight lines with full separation. In response to this legal environment, Japanese planners adapted the Dutch concept, developing their own "community streets," which slow down motor vehicles like a *woonerf*, although they continue to separate pedestrians from vehicle traffic. Figure 5 shows a conception of this concept.

This first full-fledged "community street" was a demonstration project in Osaka, in 1980, which converted a 10-meter (32.5-foot) wide street into a zigzag 3-meter (9.75-foot) wide space for vehicles by introducing strategically placed bollards and tubs containing shrubs and trees to reduce traffic speeds. This change in street design increased pedestrian traffic by 5 percent and bicycle traffic by 54 percent, while reducing automobile traffic volume by 40 percent. No major change was found in the traffic volume on adjacent streets and parking by people from outside the neighborhood was almost eliminated. The average speed of motor vehicles on the street dropped to about 5 km/hr (3 mph) and the maximum speed to 8 km/hr (5 mph). More than 90 percent of the local residents highly praised the community street.[37]

This successful demonstration project in Osaka led the Japanese Ministry of Construction to offer funding to communities across Japan to initiate similar projects to slow traffic and improve safety. By the late 1980s, over 140 such streets had been created and their popularity continues to grow.[38] Community streets have been created in two different types of environments—some are on streets near schools and parks, where children and elderly pedestrians are commonly found; others are in neighborhood shopping districts or commercial zones, where they have helped reinvigorate market areas. When community streets and traffic-calming strategies are applied on a wide-area basis for an entire neighborhood where pedestrians and cyclists are being given priority, the area is known in Japan as a road-pia. A variety of different devices, including intersection humps, chokers, diagonal diverters, chicanes, and varied pavement types are used to calm traffic in the community streets and road-pias, as figures 5 through 9 illustrate.

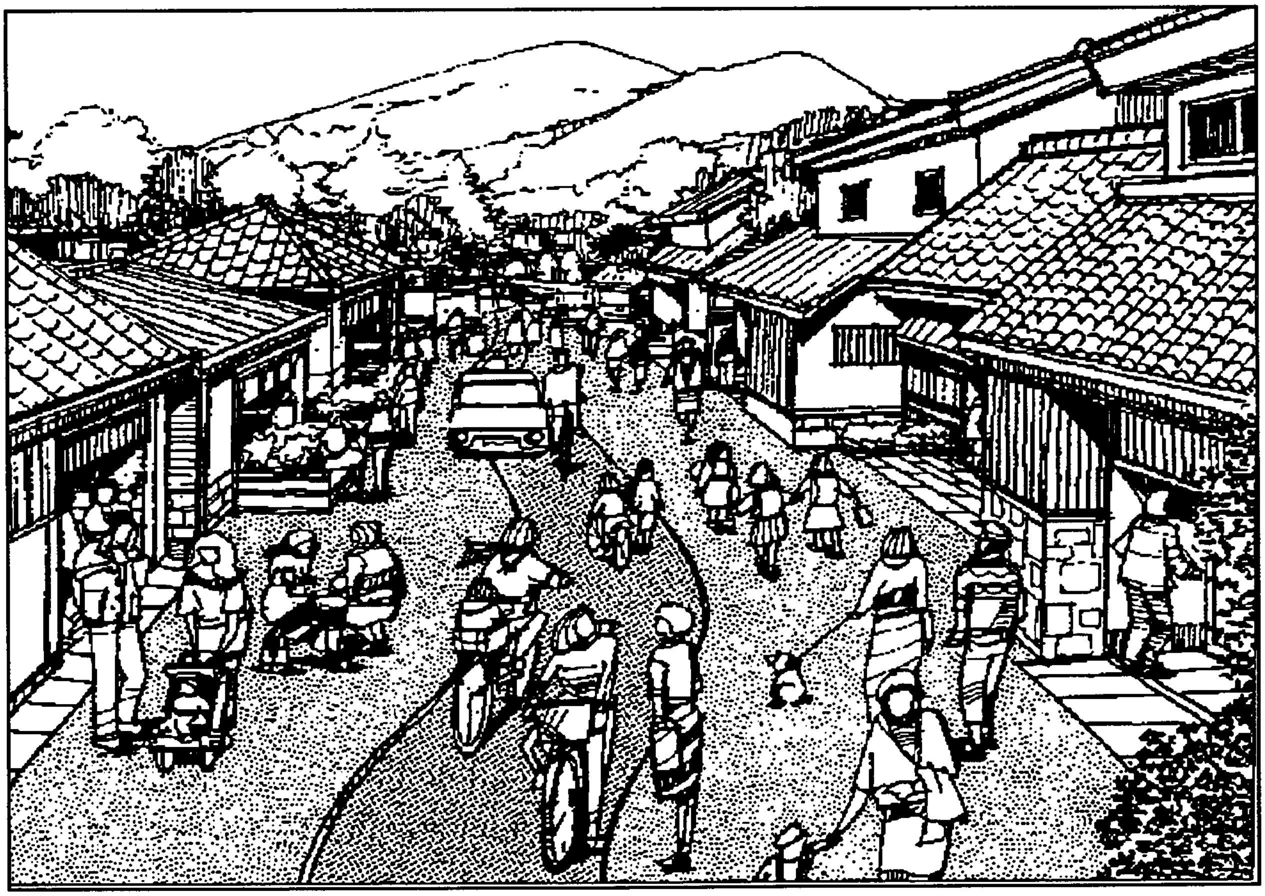


Figure 5. The Dutch woonerf concept is increasingly popular in Japan.
(Japan Bicycle Road Development Association)

Since 1984, the Japanese Ministry of Construction has been the chief advocate of creating "road-pia," which are applications of the community street concept and other traffic restraint strategies on a broad-area basis in neighborhoods where traffic and safety are a problem. Here again, the Japanese have borrowed significantly from the extensive German, Dutch, and Danish experience. Road-pia involve the creation of pedestrian priority areas surrounded by more automobile-oriented trunk or arterial roads. Within the pedestrian priority areas, a variety of techniques are used to manage traffic, including "streamlet roads," where pedestrians and vehicles mix, as in the Dutch *woonerf*, pedestrian-only streets, diagonal diverters, chokers, road and intersection humps, and sidewalks, as figures 8 and 9 illustrate.

Such wide-area treatments have been found to be extremely effective in reducing overall traffic volumes and through traffic, reducing vehicle speeds and accidents, and boosting pedestrian and bicycle use. In the 17-hectare (5-acre) residential district of Koraku, immediately north of the port of Nagoya, for example, a road-pia project introduced community streets and

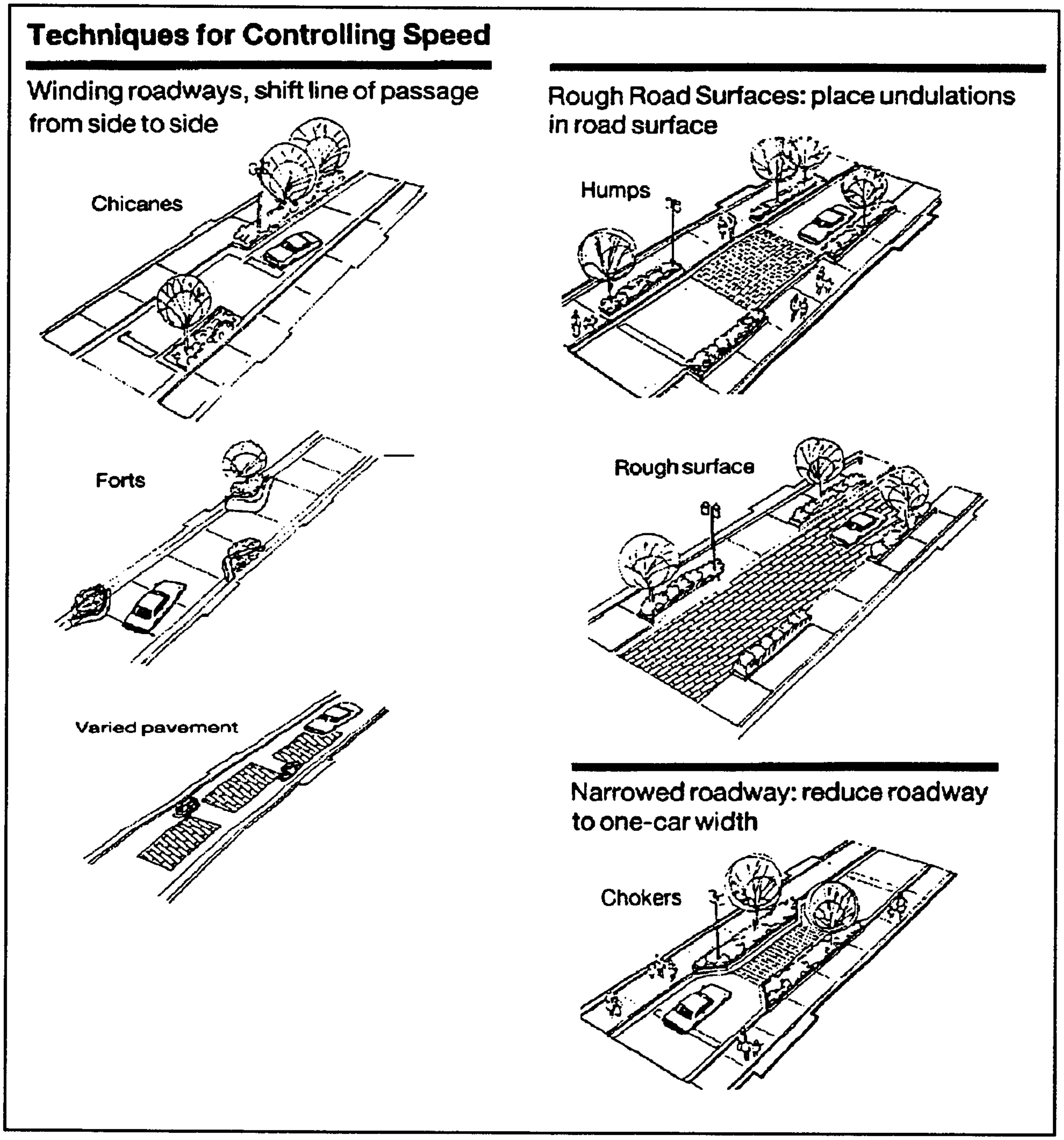


Figure 6. Techniques for Traffic Calming in Japan: Controlling Speeds

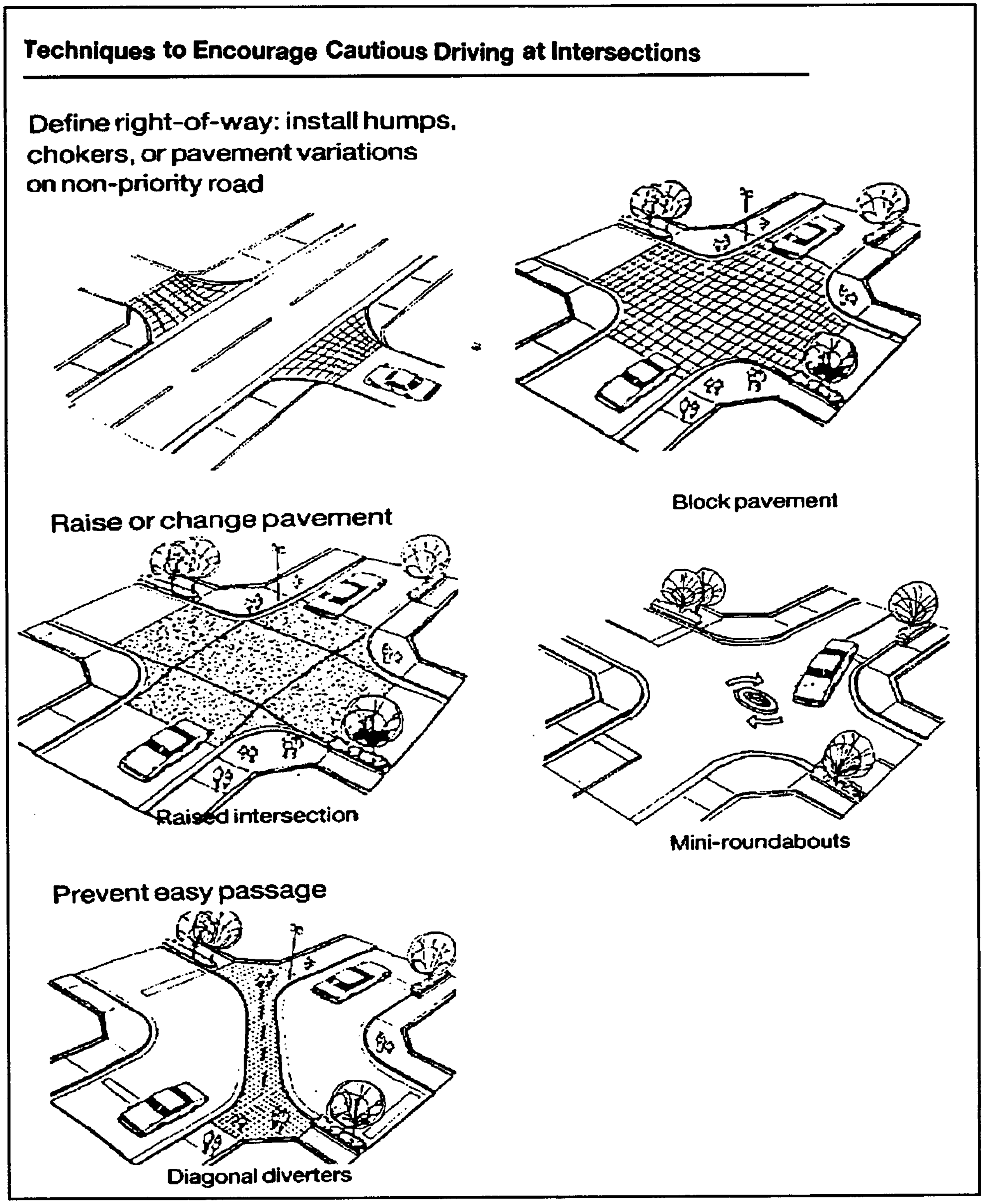


Figure 7. Techniques for Traffic Calming in Japan: Encouraging Cautious Driving at Intersections

other traffic-calming measures along the main pedestrian routes linking schools and transit stations to people's homes and at the entrances to the neighborhood, as shown in figure 8. Average traffic speed fell to 3.5 km/hr (2.2 mph) and the frequency of accidents resulting in injury or death fell from 32 in the preceding 4 years prior to the project to only two in the 2 years after project completion.[39] Figure 9 shows a road-pia scheme for an Osaka neighborhood, which emphasizes pedestrian access to the railway station with dedicated pedestrian-only or streamlet road (*woonerf*) streets.

Another traffic management technique that has promoted walking and cycling quite successfully in residential and commercial areas is the concept known as traffic cells. These have been developed in a number of cities in Europe and Japan, including Nagoya, Japan. A traffic cell system is created by establishing a network of automobile-restricted streets in a neighborhood, which cars not only cannot use, but cannot cross. These streets define the internal boundaries of the traffic cell. Pedestrians, cyclists, and public transportation can freely cross the boundaries, but automobile drivers wishing to go from one cell to another must drive out of the cell, onto a ring road arterial, and then back into another cell of the system. Thus, traffic cells eliminate through automobile traffic and tend to make the automobile a slow and inefficient mode of travel for travel within the traffic cell system, encouraging people to walk, cycle, or use transit.

In Nagoya, the introduction of traffic cells in the central area and a number of residential areas, combined with traffic signal improvements on the ring road, bus priority lanes, priority for public transport at traffic signals, and tighter parking regulations in the late 1970s led to a 58 percent reduction in traffic deaths in the central area and a 57 percent reduction in the residential areas covered by cells. The volume of traffic entering the central area in the morning peak hours decreased by 15 percent and automobile-related pollutants decreased by 16 percent, while bus ridership increased 3 percent and traffic speed on the roads covered by computer-managed traffic signals increased 17 percent.[40]

Elsewhere in Asia, traffic-calming measures have been used somewhat less but are making inroads, especially in the newly industrialized countries. In Malaysia, for example, speed restriction signs, traffic humps, and interlocking pavement blocks have been used to slow down automobile traffic in residential areas and to increase pedestrian safety and comfort.[41]

Australia. Traffic calming goes by the name of local area traffic management in Australia, where it has been gaining much more widespread acceptance since its initial introduction in the early 1970s. The City of Belmont in Western Australia was the first to develop selected measures involving partial and full road closures. Over the years, a number of local governments in the area of Perth and other cities have instituted intersection treatments and selected road closures to improve safety and reduce through traffic. In the Perth area, the cities of Stirling, Melville, Perth, and Bayswater have very been very active in promoting traffic-calming. Stirling, for example, began in the late 1970s by developing a road hierarchy and defining 20 precincts for detailed local area traffic management studies. Implementation of these plans proceeded through the 1980s.

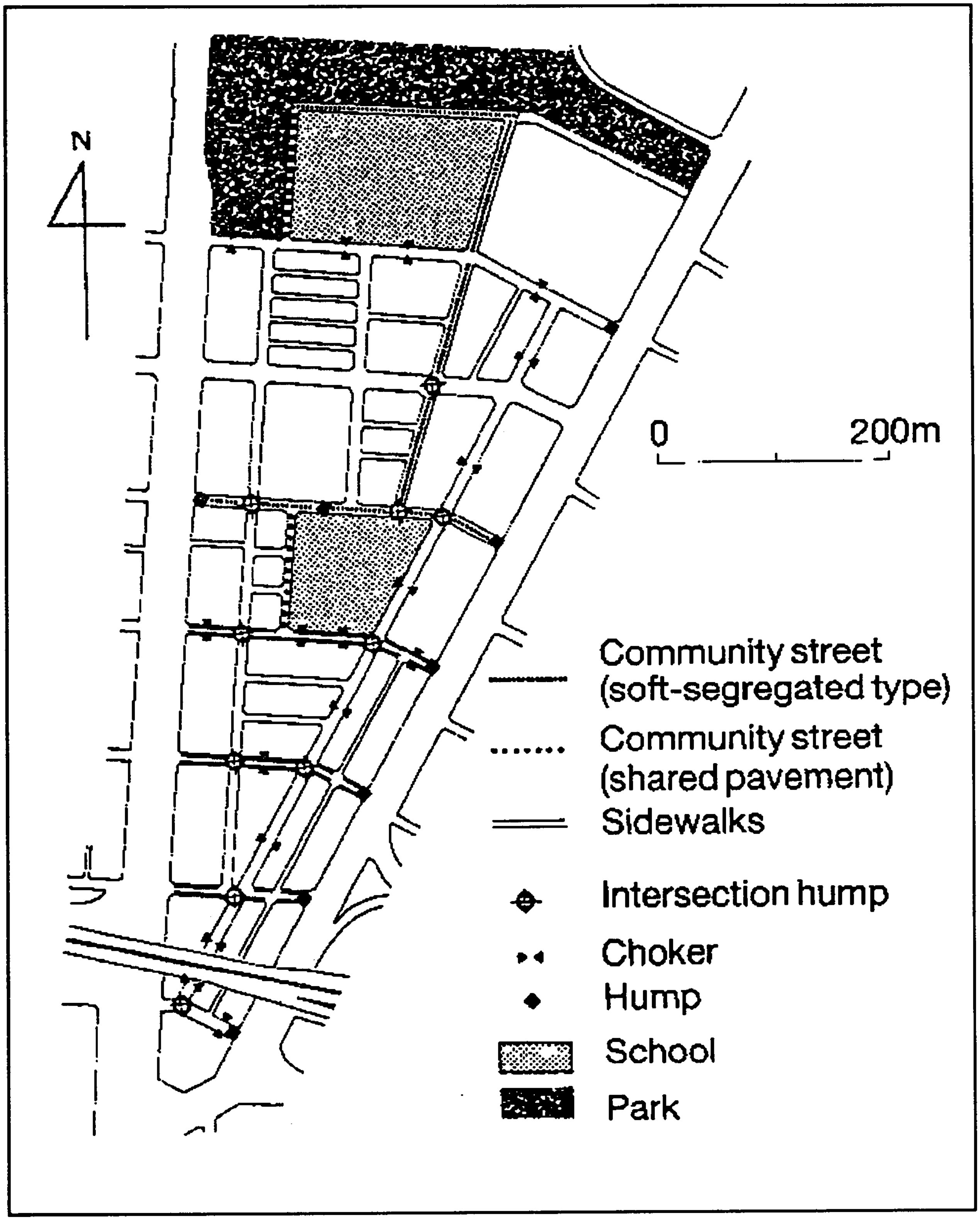


Figure 8. Traffic Restraint in Koraku Community, in Nagoya, Japan, Road-Pia

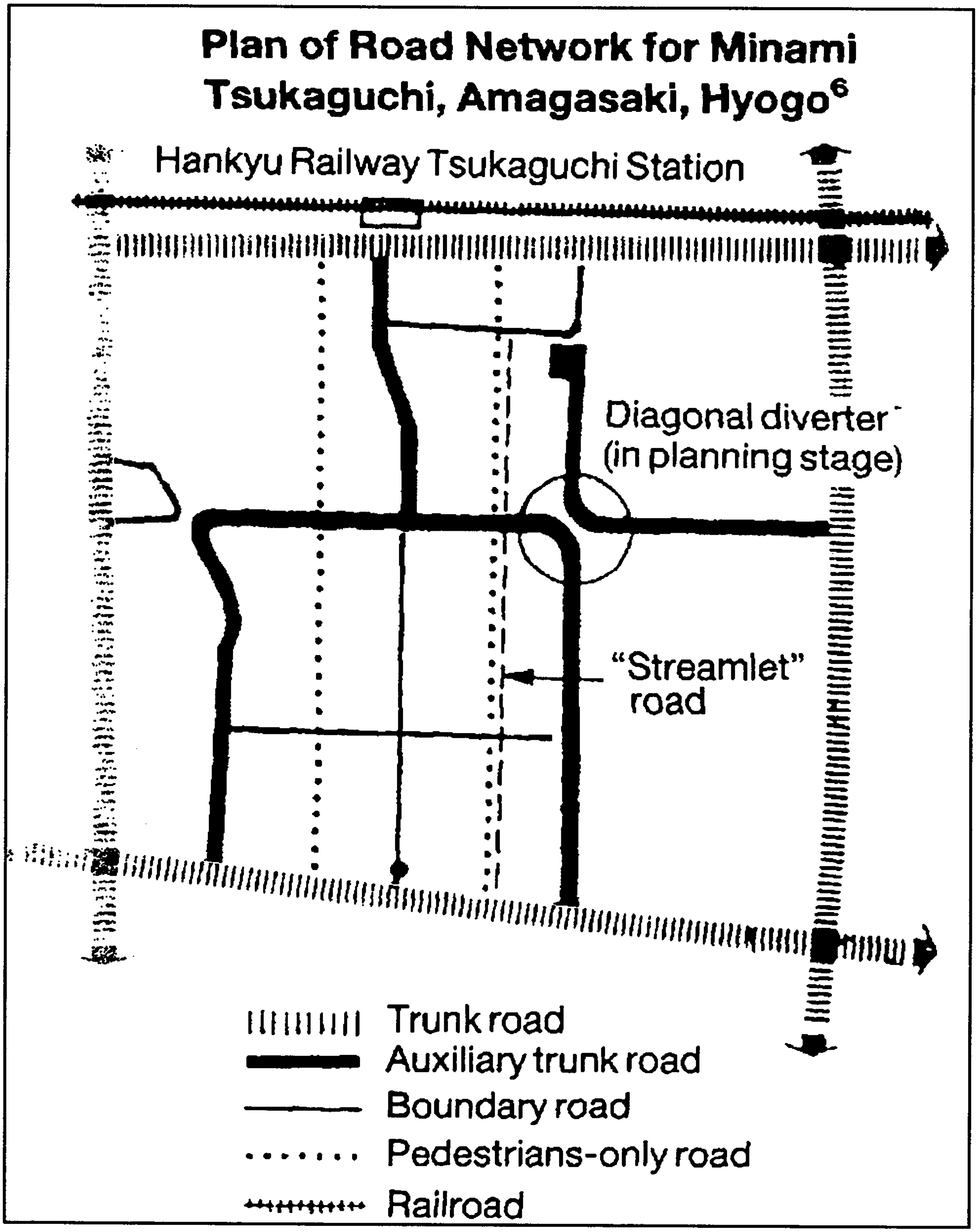


Figure 9. Osaka Neighborhood Traffic Restraint Plan (Road-Pia)

Bayswater has developed a woonerf which is operating successfully. In the area of Adelaide, in South Australia, many local governments have undertaken comprehensive residential street management plans involving street closures, speed humps, angled slow points, traffic circles, and "plateaux." The last-mentioned involve continuing pedestrian and bicycle rights-of-way across intersecting side streets at a constant elevation, forcing cars to mount a gentle cobbled ramp on either side and giving clear signals to slow down.

A simple personal computer-based interactive transportation modeling program, called MULATM, has been developed in Australia for analysis and management of local street networks and traffic planning. While designed for use by professionals with some knowledge of transportation planning or engineering, it does not require expert knowledge. It assigns a fixed-origin destination matrix to generate a set of modeled flows on a road network of up to 200 intersections, and can handle a range of road and intersection types and treatments, including road humps, turn bans, chokers, and even the introduction of *woonerf* streetscaping.[42]

Figure 10 shows a successful local area transportation management system developed in Nunawadding, Victoria, Australia, which employs eight different types of traffic-calming devices.

Bicycle Facilities

Bicycle Networks. In many low-income Asian cities where nonmotorized vehicles (NMVs) predominate, such as in China, there has been little need to create a separate cycle network because large numbers of NMVs define their own legitimacy to right-of-way. However, as motorization increases, or as traffic congestion worsens, it becomes increasingly important to develop modal separation in high traffic flow corridors. This is particularly vital in mixed traffic cities where NMV use is declining due to competition from growing motorized traffic.

Motorized modes are heavier and faster, and often accorded higher social status than NMVs. When street space is scarce, NMVs are vulnerable to displacement from mixed traffic streets unless they are present in sufficient numbers to assert an almost continuous claim to their share of road space. A key function of bicycle or NMV facilities is to protect the legitimacy and safety of NMVs in the transport system where it would otherwise be threatened by motorized traffic. Isolated bikeways and fragmented segments of bicycle paths cannot be expected to overcome the problems faced by urban cyclists. Comprehensive networks of bicycle safe roads and paths are needed to attract less skilled cyclists to use the bicycle for a significant share of their short daily trips in motor vehicle-dependent cities and to avoid the diversion of cyclists to motorized modes in mixed traffic and NMT-dependent cities.

Of the affluent countries in the region that is the subject of this report, the Japanese have developed the most thorough networks of cycling facilities. Bicycle paths are often closely spaced and well interconnected, serving most major trip destinations, such as schools, rail stations, and shopping areas, as figure 11 shows, although the design of these facilities is

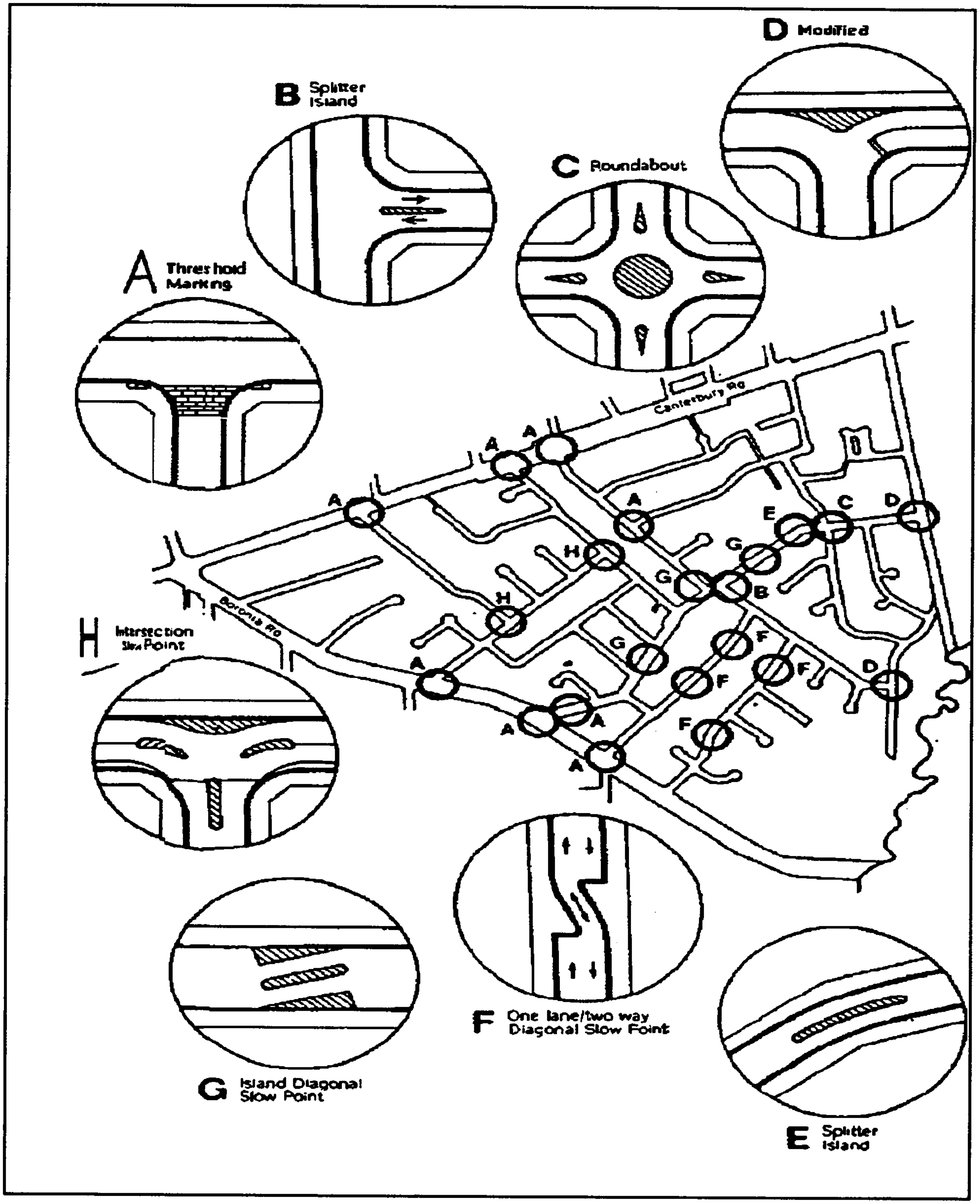


Figure 10. Traffic Calming for Local Area Transportation Management in Nunawadding, Victoria, Australia.

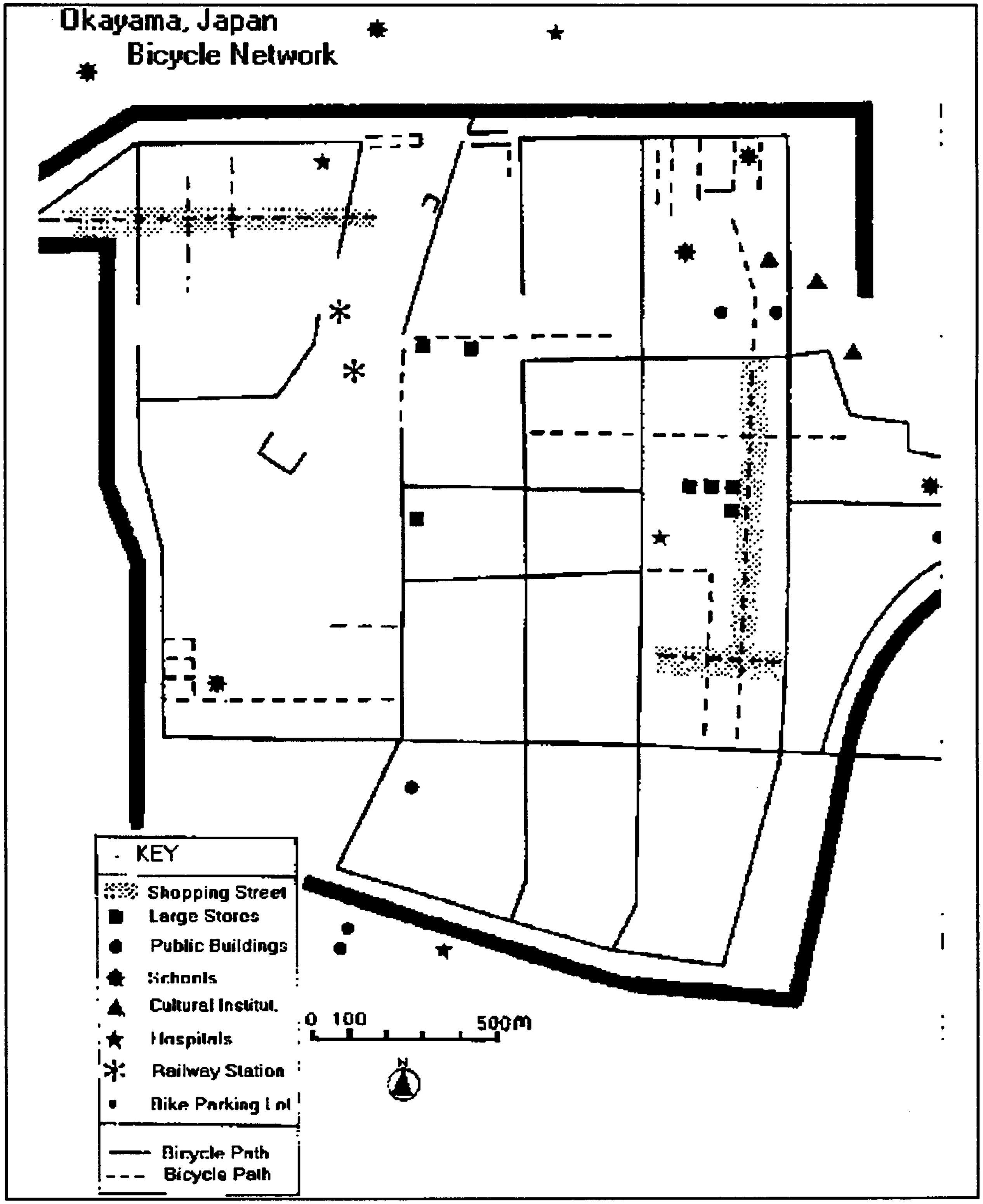


Figure 11. Bicycle Network in Central Area of Okayama, Japan, 1988
Source: Japan Bicycle Road Development Association

generally judged to be substandard to those found in many European cities. While high-quality Japanese cycle paths are found in rural areas and some suburban areas, in larger cities, the predominant shared bicycle and pedestrian paths force cyclists to share their right-of-way with pedestrians and a variety of street furniture and obstructions. Path widths are often quite narrow, sight distances may be poor, and pedestrian/bicycle conflict potential is high.[43]

Japanese cyclists appear to compensate for these factors, being conditioned by their cycling environment. They thus tend to develop different styles of cycling than those of American or Australian cyclists, who usually have little choice but to ride in the street, sharing the right-of-way of faster-moving motor vehicles. The average bicycle travel speeds in the United States appear to be substantially higher than those in Japan. However, the level of bicycle use for ordinary daily activities, especially for women, appears to be much higher in Japan than in the United States, due to land use patterns that encourage daily shopping at neighborhood stores, a safer physical environment for cycling, disincentives to automobile use, and a high degree of social acceptance of the bicycle.

A significant factor in this higher level of use is likely the widespread and growing availability of bicycle paths and traffic-calmed streets. As recently as 1970, there were no bicycle paths or lanes in Japan. Since then, the Government began a program of steady construction of over 3,000 km (1,830 miles) of new bicycle/pedestrian paths, as well as bicycle paths and lanes, each year on average, producing a network of 54,032 km (33,000 miles) of such facilities by 1988, representing 4.9 percent of the length of all roads in Japan. However, of this total, exclusive bicycle and pedestrian paths represented 3,025 km (1,850 miles) and only 1,392 km (850 miles) represented exclusive bicycle paths. Thus, Japan significantly lags many European countries in its ratio of exclusive bicycle path length to street length. In the Netherlands and western Germany the ratio of exclusive bicycle path length to total road length is 8.6 and 4.7 percent, respectively.[44]

As table 5 shows, about 90 percent of bicycle facilities in Japan are sidewalk bikeways, where pedestrians and cyclists share the same right-of-way.[45] These facilities are in addition to the over 90,000 km (55,000 miles) of sidewalks created since the mid-1960s. While this network is better than those found in many other parts of the world, it is still less than what is desired by most Japanese cyclists. A recent Japanese survey asked what the greatest obstacles to bicycling are, with half of those questioned identifying the primary barrier as inadequate separation from automobile traffic, a third calling for more safely rideable roads, and a quarter identified the need for greater separation of bicycles from pedestrian traffic.[46] It is notable that similar needs have been expressed by cyclists in similar surveys in many communities in Australia and the United States.

Table 5. Expansion of Bicycle Network in Japan 1971–87

	Lanes Added Since Since 1971 (km)		Annual Increase in Length		Percent Increase in Length	
Year	Total Bike/Ped Lanes [1]	Exclusive Bicycle Paths[2]	Total Bike/Ped Lanes[1]	Exclusive Bicycle Paths[2]	Total Bike/Ped Lanes [1]	Exclusive Bicycle Paths[2]
1971	1,197	0	1,197	0	--	--
1972	3,297	0	2,100	0	175%	--
1973	4,967	86	1,670	86	51%	--
1974	7,609	175	2,642	89	53%	103%
1975	10,558	338	2,949	163	39%	93%
1976	14,800	338	4,242	0	40%	0%
1977	17,385	599	2,585	261	17%	77%
1978	19,730	599	2,345	0	13%	0%
1979	26,121	872	6,391	273	32%	46%
1980	29,612	965	3,491	93	13%	11%
1981	31,824	998	2,212	33	7%	3%
1982	35,794	1,029	3,970	31	12%	3%
1983	39,115	1,093	3,321	64	9%	6%
1984	42,103	1,191	2,988	98	8%	9%
1985	44,957	1,179	2,854	-12	7%	-1%
1986	48,981	1,241	4,024	62	9%	5%
1987	53,899	1,321	4,918	80	10%	6%

Source: Ryozo Tsutsumi, "Safety Measurement and Parking System of Bicycle in Japan," Japan Bicycle Promotion Institute, Tokyo, 1989.

Notes: (1) Includes bicycle-only facilities, shared bicycle/pedestrian lanes, and striped bicycle lanes in streets.
(2) Bicycle-only paths, excluding striped bicycle lanes in streets.

Australian cities are beginning to develop more comprehensive bicycle networks, but the often good bicycle plans found in these cities are generally quite short of full implementation. Among the cities cited as having long-established, above-average bicycle networks are Canberra, the planned city that is Australia's capital, and Crestwood in the vicinity of Perth. Some Australian bicycle planning efforts, such as the Geelong Bike Plan, have explicitly avoided establishing a network of bicycle routes, arguing that what is needed to serve the vast majority of short local trips are shortcut paths across parks and other spot improvements to build on the existing road network for motor vehicles.

New Zealand is making progress in developing networks of cycling facilities as well. In Christchurch, the Canterbury Regional Council in 1986 adopted a plan for a network of cycle routes, including off-road cycleways, marked cycle lanes on roads, and lengths of roads with little motor vehicle traffic. Bicycle routes, however, are generally being kept off of main arterial roads, making most use of local roads, with special links created to achieve directness, for example, cutting through cul-de-sacs, through residential blocks, public land, parks, school grounds, and alongside rivers, railways, and drainage easements. The plan calls for a cycle route network at least as dense and comprehensive as the arterial road network. Route specification and network detailing are being handled through district planning efforts.[47]

Classification of Bicycle Facilities. The concept of network functional hierarchy used in classifying highways and evaluating their spacing is equally useful in planning and designing cycle networks. Conditions for cyclists and other slow traffic can be optimized if NMVs have available a fine-grained network of **collector** facilities—often shared with pedestrians and slow motorized traffic—along with a coarser network of **primary** slow traffic facilities, some shared with pedestrians and slow motorized traffic and many reserved for exclusive NMV use, and a coarse network of exclusive **arterial** facilities designated for NMVs.[48]

In a recent Chinese urban road traffic manual, bicycle facilities were divided into five types, with the first two types being recommended for large and mid-size cities: [49]

(1) **Special Bicycle Roads,** independent of the road network and dedicated to bicycle use only. A network of such roads is being created in the CBD of Shen Zhen City.

(2) **Semi-Independent Bicycle Roads**, positioned on one or two sides of motor vehicle lanes with physical separation.

(3) **Nonindependent Bicycle Roads**, positioned on one or two sides of motor vehicle lanes but without physical separation.

(4) **Mixed Traffic Roads**, where motor vehicles and bicycles share the same right-of-way. These would be widely varying in form, involving traffic-calming measures in some cases, not in others.

(5) **Pedestrian-Bicycle Roads,** where bicycles and pedestrians share the same right-of-way. These would vary widely, but might be most comparable to many Japanese bicycle-pedestrian roads and paths.

The Importance of Networks. While the spacing of networks must be adjusted for city patterns and densities, this network concept has been used successfully in a number of highly motorized cities, mostly in Europe, to arrest and often reverse the decline of NMV use during times of rapid motorization. Several cities in Asia outside of Japan are noteworthy for their bicycle networks, including Tianjin, China, and Pune, India, which have been working to develop an extensive cycle network for a number of years. The Australian national capitol city of Canberra, which was developed as a planned city, has developed the most comprehensive urban bicycle network in Australia. With assistance from the World Bank, Shanghai, China, is expanding its bicycle network as part of traffic management plans, in many cases by dedicating underutilized alleys to bicycle traffic. More than 150 km (92 miles) of new bicycle roads are planned for development in Shanghai over the next few years.

Officially dedicated NMV facilities are rather common in Chinese cities, but not widely found elsewhere in Asia, except for Japan. Instead, where NMVs make up a major portion of traffic flows, they frequently define NMV "lanes" through their physical presence in large numbers. This has been the situation in China, where low levels of investment in public transportation in China over the past several decades, combined with strong support for bicycle use, have enabled cyclists to dominate the traffic mix on most streets. However, in cities with extensive use of NMVs that lack NMV lanes defined by physical separation, extensive mixing of NMV and MV traffic often fosters poor traffic discipline among all modes, which exacerbates traffic congestion and safety problems. As motor vehicle volumes grow, unless there is an official allocation of street space for NMVs, these slower and more vulnerable modes are almost inevitably displaced over time by faster, heavier, aggressive automobile, truck, bus, and motorcycle traffic.

The Importance of Good Facility Design. The design of transportation facilities can significantly affect traffic safety. Segregation of slow from fast traffic, careful design of intersections to maintain good sight distances, to reduce turning conflicts, and to channelize traffic to enhance predictability of flows can all reduce safety problems while improving operational performance. Poorly designed and improperly maintained separate cycle facilities can lead to an increase in safety problems, particularly if there are many intersections or driveways crossing the cycle paths and sight distances are poor. This is a problem that afflicted many bicycle paths created in Australia and the United States in the 1970s and led to opposition from some cyclists to creation of additional bicycle paths.

Traffic discipline is often rather lax in Asian cities for both NMVs and motor vehicles. Congested conditions, extensive encroachments of nontransportation activities into rights of way, bus stops and rickshaw stands that are not provided space out of the primary right-of-way, and other unsuitable facility designs often exacerbate this problem. Provision of off-street locations for such activities can enhance transport system efficiency.

In some developing countries of Asia, such as Bangladesh, design standards from highly motorized countries have been used with insufficient tailoring to local traffic conditions and economic realities. This has often led to unsafe designs that have not taken advantage of opportunities to create greater separation of slow NMV traffic from fast heavy vehicle traffic, contributing to safety problems. Further efforts are needed to ensure the application of appropriate design standards for different types of traffic mixes under various conditions and right-of-way opportunities.

Capacity of NMV Facilities. The rapid growth of bicycle traffic in Chinese cities in the 1980s has led to serious traffic congestion problems in many cities. Peak hour flows at many main intersections in Beijing and Tianjin exceed 15,000, with 29,000 per peak hour observed at one main junction in Beijing.[50] As a result, interest in assessment of the capacity of bicycle facilities has been a serious matter for Chinese planners. In Beijing, practical saturation capacity of a separated bike track has been estimated at 0.5 bicycles per second per meter width (0.3 bicycles per second per foot width), or 1,800 bicycles per hour per meter width (1,100 bicycles per hour per foot width). Cycle-rickshaws typically require 1.5 to 3.0 times the capacity of a single bicycle, depending on size and weight.[51] Mixed traffic streets typical of Beijing, China, show a saturation capacity of about 0.37 bicycles per second per meter width (0.23 bicycles per second per foot width), or 1,330 bicycles per hour per meter width (800 bicycles per hour per foot width). Separation of motorized and nonmotorized traffic at intersection approaches with fences is becoming increasingly common in China as a traffic safety measure. Recent studies indicate that this strategy likely increases motorized traffic capacity of intersections without diminishing bicycle traffic capacity.[52]

Allocation of Road Space Between Motor Vehicles and NMVs. The capacity of different types of rights-of-way to move people at different speeds has been the subject of some debate in recent years, especially in evaluating transportation strategies for Asian cities, where street space is scarce and saturated due to high development densities and growing rates of both motorized and nonmotorized vehicle ownership. Some analysts have argued that because nonmotorized vehicles are less efficient in their use of street space than public transportation, cycle-rickshaws and bicycles should be discouraged and gradually phased out, for example in China.[53] Such arguments, however, have not accounted for the complementary function of different transport modes to meet needs for different trip lengths and purposes, or the affordability of various modes both for individuals and regions.

This issue is of vital importance in considering transport strategies in Asian cities, where rapid economic development and population growth provide conditions for the rapid change of transportation and land use patterns. Opportunities to travel by nonmotorized transportation have shrunk dramatically in Bangkok with the banning of cycle-rickshaws several decades ago and the gradual elimination of most safe places to bicycles due to rapid motorization, road space allocation favoring motorbikes and cars, policies that have paid no attention to pedestrians and cyclists, and long-term accompanying changes in land use that have fostered sprawl. Many Indian cities are poised to lose their modal diversity under similar policies and forces. This same process has already resulted in substantial automobile dependence in Australia and New Zealand, and has gone farthest in the United States Japan and many European countries, however, demonstrate that such a pattern is not the only path to modernization and wealthy, healthy communities.

Where street space is scarce, whether it is in a dense Asian city, or in an urbanizing American suburban center, attention to the efficiency of various modes in their use of street space should be a primary concern of transportation planners. For a given amount of road or corridor space, the most efficient modes of transportation are generally rail or bus modes operating on their own dedicated rights-of-way. The least efficient use of road space is low-occupancy automobiles. Bicycles fall in between this range, with road space utilization approaching that of buses in mixed traffic. Motorcycles, scooters, and other two-wheeled motorized vehicles are somewhere in between automobiles and bicycles in their road space utilization. All of these general estimates of road space utilization are subject to a great deal of variation in the real world, depending on vehicle occupancy, level of traffic congestion and traffic mix, topography, frequency of public transport stops and other details of public transport operations, quality of track or road surface, and other factors.[54] However, they are important general relationships that should be considered when rationing street space among modes.

The function of modes and distribution of trip lengths that must be accommodated within travel corridors is an important consideration in evaluating how scarce road space should be most efficiently allocated between trip purposes and modes. If a large share of traffic is of short trip length, as in smaller cities and towns in Japan, rail modes are not practical to accommodate these trips, and walking and cycling will have a greater potential use as primary modes. If a large share of traffic is of long trip length, bicycles and walking are not likely to be the most efficient or practical modes on their own for many trips, but will assume greater importance as feeder modes to and from rail transportation, as in large Japanese metropolitan areas. If resources are unavailable to provide bus transportation sufficient to meet demand, bicycles may be more efficient than an overburdened public transport system, even for longer trips, as in most Chinese cities, including even the megacity of Tianjin, with nearly 10 million people, where 80 percent of vehicle trips are by bicycle. Often in Australia and the United States transportation plans and operations fail to provide any safe dedicated street space for bicycles and pedestrians, forcing even those traveling a very short distance to use a car, whether to go from home to a nearby shop for milk, or from one shopping arcade to the next.

Even in cities where streets are generally quite congested, it is often possible to find underutilized street space. For example, an ongoing World Bank project in Shanghai has identified opportunities to use alleys to provide right-of-way for a dedicated bicycle network, relieving some pressure from main roads and intersections. Similar opportunities exist in other cities, such as Bangkok. In Australia and elsewhere, motor vehicle lanes have been at times narrowed by restriping in order to create wide curb lanes, separated bike lanes, and improved sidewalks. Removal of parking from along one or both sides of a street offers another opportunity to expand pedestrian and bicycle space. Where space cannot be found, NMVs and public transport should be favored in allocating street space if transport system efficiency is a concern.[55]

Bicycle Parking

Bicycle parking can be an important factor in determining the viability of bicycle use, especially if theft and vandalism are problems. There is wide variation in both rates of bicycle theft and availability of parking for bicycles across the Asian and Australian region.

Thanks to its high degree of social cohesion, low incidence of poverty, and other factors, bicycle theft rates are very low in Japan compared to elsewhere in the world, amounting to roughly one-fifth the per capita bicycle theft rate of the United States.[56] This has made it possible for Japanese cyclists to park in any open space in front of shopping areas and rail stations without needing to lock their bicycle to a fixed object. With the growth of cycling in the 1970s, "bicycle pollution," caused by thousands of disorderly parked bicycles in such spaces, became a much debated problem. Concern over the growth in the number of parked bicycles at rail stations led the Japanese government to adopt legislation in 1977 and again in 1980 to dramatically expand the bicycle parking supply while regulating locations where bicycles can be parked and providing for the removal of illegally parked bicycles. If seized, bicycles are stored for a fixed period and the owner contacted. Unclaimed bicycles are scrapped or recycled for use in developing countries. Japan's 1980 Bicycle Law provides that newly constructed or enlarged department stores, supermarkets, and banks must provide bicycle parking. Another section of the law provides for the creation and management of publicly-operated bicycle parking garages in public areas, such as near rail stations.[57]

More research is needed to identify data on bicycle parking supply and theft rates in Asian cities. However, theft is a significant barrier to more widespread use of bicycles in cities in many parts of the world. While this is not a major problem in many Asian cities, in others it may be. Theft was seen as a deterrent to cycling for many noncyclists living in 10 low-income neighborhoods of Delhi, India, according to a 1985 survey. However, this survey found that cyclists in the sample had not experienced many theft problems. Only one percent of cyclists reported having a bicycle stolen from them, although virtually all took steps to avoid such problems. In most cases, this involved simply using the built-in locking devices on Indian bicycles that prevent the rear wheel from turning while locked. Such devices are common on bicycles throughout Asia including Japan. About one in 10 cyclists reported also using a padlock and chain to secure their bicycle to a fixed object.[58] Bicycle parking assumes many forms in Asia but is most often completely informal. In larger cities in India and China, guarded bicycle parking areas, often fenced and with weather protection, are available for a small daily fee for bicycle commuters or cyclists who leave their bicycles at railway stations.

In Australia, as in the United States, the gap between the rich and poor is large and growing and an emphasis on individual freedom has brought only weak social controls compared to more group-oriented Asian cultures. As a result of these and other factors, crime and bicycle theft are serious problems. Secure bicycle parking is in short supply. There are no guarded bicycle parking garages anywhere in the country, and cyclists must depend on heavy U-shaped locks affixed to parking meters, poles, and other fixed objects for most of their parking. Although the provision of secure racks and lockers is growing, it still falls far short of the need for parking. A rapid increase in bicycle thefts at Melbourne transit stations, for example, was seen to be the major cause for a sharp reversal in the growth of bike-and-ride travel in the mid-1980s.[59]

Integration of Bicycles with Public Transportation

The experience of Japan and Europe shows that access to and from public transportation is one of the most important roles for bicycle transportation in the late 20th century, especially in larger cities. Bike-and-ride services expand the potential market area of high-speed public transport services at low cost without the very high air pollution emission and energy use rates, excessive space requirements, and high capital costs of automobile park-and-ride systems. This link with express public transportation is one of the most valuable potential functions of bicycles in large cities, where average trip lengths are long. Integration of bicycles with public transportation is also an important strategy for sustaining nonmotorized and public transportation mode shares in rapidly motorizing cities with mixed traffic systems, for reintegrating bicycles into motor vehicle-dependent cities, and for dealing with network capacity saturation in lower income cities dependent on nonmotorized transportation.

Such systems have demonstrated their popularity in a number of cities in China and India. To reduce growing urban bicycle traffic congestion, the Chinese have been establishing bicycle-subway and bicycle-bus exchange hubs which can attract long-distance bicycle commuters to transit, freeing congested road space in cities such as Beijing.[60] Hundreds or thousands of bicycles can be seen parked at some railway stations in India, such as in Madras.

In Japan, as in Western Europe, the fastest-growing and sometimes predominant access mode to many suburban railways is the bicycle.[61] Effective integration of bicycles with public transportation depends on several factors, including adequate supporting infrastructure, such as secure parking at station entrances and safe access routes, and the climate of community opinion about use of bicycles, which is shaped over time by educators, community leaders, the media, employers, families, and past experience and habits.

Between 1975 and 1981, the number of bicycles parked at Japanese rail stations quadrupled to 1.25 million, prompting great concern over the "bicycle pollution" problem, caused by the thousands of disorderly parked bicycles crowding rail station squares. By the end of the 1980s, more than 3 million bicycles were used daily to access suburban railway stations in Japan. Use is heaviest in the moderate and lower density suburban fringe areas of large cities, where 15 to 45 percent of rail station access is by bicycle.

In the Tokyo Region as a whole, the share of access trips in suburban areas made by bicycle rose from 4 percent in 1975 to 11 percent in 1980 and 13 percent in 1985, when about 940,000 bicycles were parked daily at stations in the region. The Chukyo Region of Japan witnessed a similar increase, from 12 percent bicycle access in 1975 to 23 percent in 1980 and 27 percent in 1985, which translated into about 220,000 bicycles at stations each day. During this same time, walking trips for station access declined in the Tokyo Region from 71 percent in 1975 to 63 percent in 1985 and bus access dropped from 22 percent to 18 percent. In 1985, automobiles accounted for only 2 percent of Tokyo Region rail station access and motorbikes for about 4 percent. In the Chukyo Region, walk access declined from 58 percent to 44 percent and bus access from 24 percent to 16 percent in the same period. By 1985, in the Chukyo Region, automobile park-and-ride amounted to 7 percent of station access and motorbikes for 6 percent.[62] Automobile park-and-ride access, while growing in the late 1970s, actually decreased slightly in some regions of Japan, while remaining stable in others, during the first half of the 1980s.

Japanese transportation policy and investment have encouraged bike-and-ride system development. In Japan, more than 730,000 new bicycle parking spaces were built at rail stations between 1978 and 1981, supported by national subsidies available to both public and private sector parking developers. By 1981, there were 636 garages at Japanese rail stations, each accommodating more than 500 bicycles, with 5,456 other station parking garages of lower capacity. By 1989, total parking capacity had grown to 8,735 facilities with a total capacity of 2.77 million bicycles. Of these, about three-fourths were controlled by State or local governments, about one-eighth were controlled by private sector businesses, and the remainder by the railways, public corporations, and other organizations.[63] Two-thirds of these garages were located within 100 meters (325 feet) of the station entrance and the median size of these parking garages was 500 to 1,000 bicycles, although over one-third accommodated less than 500 bicycles. An increasing number of these facilities are computerized or automated multistory structures providing very high-density parking.[64] Underground bicycle storage facilities are also growing, although their cost is relatively high. Subsidies amounting to one-third to one-half of the construction costs are available from the national and prefectural (state) governments in Japan for construction of new public bicycle parking garages. Privately developed bicycle parking garages are encouraged through subsidies from the Government, low-interest financing, and tax benefits.

Bike-and-ride access systems appear to be one reason for the continued high level of use of railways in Japan, despite substantial suburbanization and rising automobile ownership. While park-and-ride transit access is being developed in a few distant Japanese suburban areas, bike-and-ride access plays a much more important role in these areas, permitting denser development around stations rather than devoting expensive, high-accessibility land near stations to the low-intensity use of car parking. Moreover, secure bicycle parking garages, unlike park-and-ride lots, allow many Japanese commuters to leave a second bicycle parked overnight at a station, permitting egress from stations to workplaces or schools otherwise beyond easy walking distance of the stations each morning.

No information on bike-and-ride services in New Zealand is readily available. However, in Australia, the experience with bike-and-ride transportation has been more similar to the United States, with low levels of support and low levels of use. A high incidence of bicycle vandalism and theft at railway stations in some Australian cities, fostered by a lack of secure parking and growing economic distress of low-income people, has resulted in the decline of bicycle use for access to transit, despite sharp growth in the 1970s and early 1980s, as figure 12 shows.

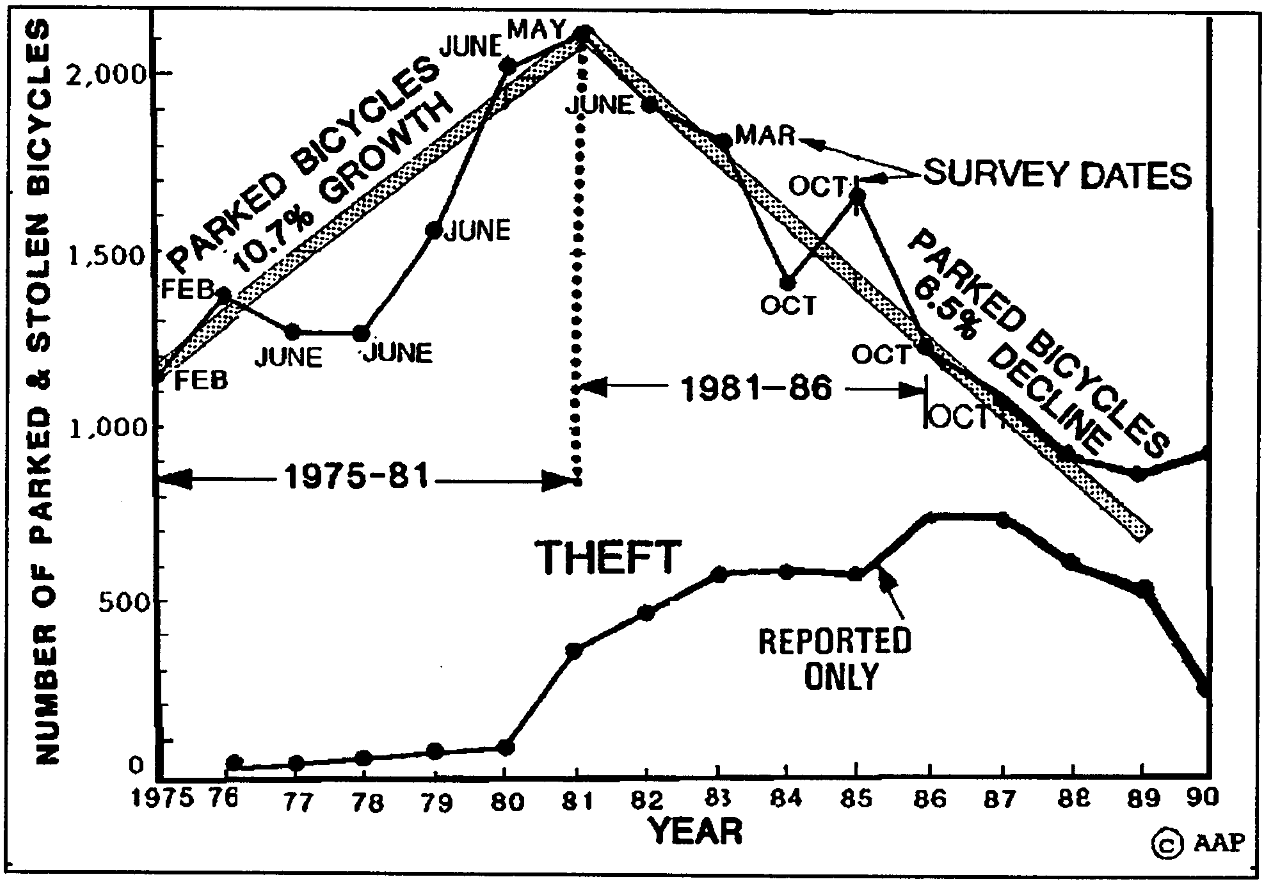


Figure 12. Bicycles Parked and Bicycles Stolen at Melbourne, Australia Rail Stations
(Reprinted by permission of Alan A. Parker)

For example, in Melbourne, supervised lockup rooms and racks on station platforms were provided up until the mid-1970s, when some 3,000 poorly designed bicycle racks were installed, mostly in places more accessible to thieves than the station platforms. Between 1980 and 1987, about 4,500 bicycles were stolen at Melbourne rail stations, and the number of thefts continued to increase. As a result, the number of people cycling daily to Melbourne rail stations dropped from 2,200 in 1981 to only 900 in 1987. Limited steps were being taken by the Melbourne transit operator in response to this problem in the late 1980s, including trial installation of 200 bicycle lockers and chains attached to fence posts on the platforms of fewer than half of the region's fully manned stations.[65] In one Melbourne station, a video camera overlooking bicycle racks and lockers seems to have effectively deterred theft and vandalism. While the current situation appears to be difficult for bike-and-ride services in Melbourne, if there were major improvements in bicycle access and parking, some see the long-term potential for as many as 200,000 Melbourne area bike-and-ride rail and bus users.[66]

Bicycle Rental Services. Bicycle rental services are a notable component of the urban transport system in some communities, especially in Japan. Developed mostly at railway stations, rental bicycle services enable some commuters to avoid the chore of bicycle maintenance and enable visitors and tourists access to the community at low cost.

In some Japanese communities, Rent-a-Cycle Ports have been developed with fleets of interchangeable minicycles and specially designed multistory garage facilities that can hold bicycles at extremely high storage densities. The same bicycle will often be rented out several times a day—used once by a local resident to reach the station in the morning, used a short time later by a local worker to get to a nearby job in a suburban satellite city, returned later to the garage by that worker on his way home by railway, and yet again by another local resident returning back home. This system is especially valuable in reducing the number of bicycles that need to be stored in the valuable land immediately outside rail station entrances.

In Australia and New Zealand, rental bicycles are more commonly engaged by recreational cyclists who use them to tour on the growing number of recreational cycling paths.

Bikes on Transit. By carrying a bicycle on board a transit vehicle, a cyclist can often make use of public transportation for trips that otherwise would not be possible by transit, due to inadequate or unavailable connector services at the origin and destination of the trip. Where transit service is provided in a dense network and where land uses are clustered around transit nodes, as in most of Asia, bike-on-transit services are less important to address transportation needs. In many parts of Asia, inadequate and overcrowded public transportation provides little opportunity for such services to be practical.

However, in areas where land use is more sprawling and where a significant share of people and jobs are beyond walking distance of major public transportation service, bike-on-transit programs can fill real needs, expanding the market for public transportation in off-peak conditions at very low cost.

In Australia, transit agencies are beginning to adopt bike-on-transit programs. Sydney Ferries in 1991 began to permit free bicycle travel for the first time. The New South Wales State Rail Authority also began to carry bicycles for free on its express passenger trains, however requiring that they be bagged or boxed. Also in 1991, Melbourne commuter trains have begun to permit cyclists to bring their bikes on trains between 9:30 a.m. and 4:00 p.m. and after 6:00 p.m. on weekdays, and all day on weekends and holidays. These changes have made it possible to make a far larger share of journeys in several metropolitan regions using bicycles and public transportation, with travel times more competitive with the automobile.[67] No information is readily available on bike-on-transit services in New Zealand.

Land Use Planning and Management

Land use patterns are fundamental to determining the share of trips that can be easily made by walking or cycling. Sprawling patterns tend to produce long trip lengths and dependence on motorized transportation modes, while clustered patterns tend to offer more opportunities for walking and cycling. Very large monocentric cities also tend to promote long trip lengths. Walking and cycling mode shares are inevitably highest in smaller cities and in large cities that have been structured in a polycentric form, as a constellation of smaller cities. These attributes can be clearly observed in the region under discussion, where walk and bicycle shares are highest in the cities with clustered development patterns, such as in Japan and China, and lowest in the sprawling, motor vehicle-dependent cities, such as Bangkok and the large cities of Australia.

However, it is not only the macroscale urban form that influences the potential for walking and cycling, but also the microscale mix of land uses. In Australian cities, like those in the United States, separation of land uses—residential development here, commercial development elsewhere—tends to reinforce automobile dependence, especially in newer suburban areas that have sprawled at low density far away from core urban centers and major public transportation lines. This pattern of development has been encouraged by low gasoline prices, extensive availability of free parking at workplaces, and tax policy, as well as relatively fewer land use controls, as in the United States.

Clearly, the scarcity of developable land in Japan and much of the rest of Asia has provided an impetus to high-density development patterns at both the macro and micro levels, while the large land masses of North America and Australia have provided no such influence on metropolitan development patterns in those regions. However, development patterns everywhere have been guided by the prevalent transportation technologies of the day and their requirements. Prior to invention of the streetcar, dependence on walking required dense, mixed-use urban forms. With the streetcar, cities expanded substantially in size and declined in average density. Where automobiles became the dominant form of metropolitan mobility, cities exploded into low-density sprawling patterns in the absence of land use controls.

Japanese land use controls, tax policy, transportation pricing policies, and infrastructure investment priorities have been very effective in reducing the growth of automobile dependence and in creating dense cities where a significant share of trips can be made by walking and cycling. Most residences are within walking or cycling distance of public transportation and basic daily services; and development has been tightly constrained in its location. Overcentralization of the economy in Tokyo has been a major concern of national land use and economic policy and many steps have been taken to encourage the development of satellite cities linked by high-speed rail, commuter rail, and mass transit.

The Japan's City Planning Law, which was completely revised in 1969 and revised again in 1980, has provided the basic framework for urban planning in Japan. This law was crafted to help protect scarce agricultural farmland from being urbanized and to promote more efficient and rational urbanization. A primary feature of the law is the distinction it makes between areas designated for urbanization and areas with strong restrictions on building. The law is used to establish areas designated as already urbanized or slated for urbanization within the next decade, where infrastructure investment is concentrated. In urbanization control areas, development is restricted and urban infrastructure investment is not undertaken. Two-thirds of the population lives in the 3.6 percent of the land area that is designated as urban promotion areas, and about 10 percent of the land area and population are found in urbanization control areas. Only 10 percent of the population, but three-fourths of the land, is in areas outside urban planning, where urban infrastructure is also not provided and development is discouraged.

In the United States, several states, including Oregon, Florida, New Jersey, and Washington, have recently adopted land use policies that begin to move towards channeling development into more efficient urban clusters, although to date, these efforts are relatively weaker than those found in Japan and Europe.

V. Education, Promotion, and Regulation

It has become relatively well accepted that to be successful in promoting the greater use of any particular transportation mode, multiple strategies are needed to reduce physical, economic, psychological, and social barriers while enhancing the safety, comfort, speed, and status of those who use the transport mode. Infrastructure and pricing play a vital role in shaping perceptions of a mode's utility, safety, and status. However, programs for education, marketing, and promotion can also have a major influence on traveler behavior and system safety and performance.

There is no readily available information on education, promotion, or regulatory programs related to walking in Asia, Australia, and New Zealand. As a low-cost mode of transportation available to nearly every person, walking has received little attention from transportation policymakers, educators, and regulators, who have focused their attention far more on motorized modes of transportation, and to some extent on nonmotorized vehicles.

Successful promotion of cycling is commonly regarded to be dependent on the existence or development of a network of bicycle-friendly streets and routes, but in the absence of a supportive cultural context, bicycle use will not attain its potential. If bicycling is seen by many to be a mode for the poor, or only for the young, or only for recreation, or is widely held to be a dangerous activity or one unsuitable for use in cold or hot weather, community education, marketing, and promotion programs may be of equal or greater importance in stimulating bicycle use than providing better facilities for cyclists. If unsafe bicycle riding habits are widely practiced, bicycle education programs, especially for young people, may significantly reduce safety problems. If most of the existing street network is designed in a way that is hazardous to cyclists and pedestrians, a few isolated bicycle paths or pedestrian streets, even if combined with promotion programs, will do little to address the widespread problems of the community and may be less effective than more widespread spot safety improvements combined with bicycle education programs. If bicycle vandalism is a problem, providing bicycle racks at transit stations may be completely ineffective in the absence of crime prevention efforts in design and operations. If most commuters get free parking at their workplace, inducements to bicycle commuting will need to be far stronger to effect the same change in modal usage.

In short, if the goal is to preserve or attain high levels of bicycle use and safety, then significant ongoing efforts are needed not only in engineering, but also in education, encouragement, and enforcement of traffic laws.

Bicycle and Pedestrian Education and Safety

Australia has developed notable bicycle education and safety research programs. The adoption of the Geelong Bike Plan in 1978, with its then innovative emphasis on the "4-E's: Education, Engineering, Enforcement, and Encouragement," helped to spur a number of initiatives across Australia in all these areas. One of the products of the Geelong Bike Plan was the Bike-Ed program for children 9 to 12 years old.[68] This 1- or 2-year course includes on-road training to teach young people bicycle riding skills and road use rules. By the mid-1980s, this course had spread to schools across several states of Australia. Evaluations of the program found that it was cost-effective in significantly reducing bicycle accidents. By the late 1980s, both on-road and classroom bicycle education for young students was becoming common in much of Australia. For example, by 1988, nearly 40 percent of 8-, 9-, and 10-year-old children in Victoria were receiving on-road bicycle safety classes, with an even larger share receiving classroom bicycle safety training.[69]

In New South Wales, a new health studies program was initiated in the early 1980s to train kindergarten and primary school children in pedestrian safety in their earliest years, gradually introducing on-road skills towards the later primary school years.[70]

The Geelong Bike Plan also introduced the idea of stronger enforcement of traffic laws on cyclists. This has taken a variety of forms, such as the issuance of "Bicycle Offense Reports," which are warnings, to young traffic lawbreakers, with a copy sent to the child's parents. On second warning, the parents are required to come into the Police Station for a formal caution. This strategy has been used in a number of cities in Victoria and New South Wales. In the latter, police also were instructed in the early 1980s to issue on-the-spot $10 fines to cyclists over driving age riding on footpaths.[71] Police in Victoria and some other Australian states are offered bicycle safety training and may assist in school bicycle safety programs.

In Japan, governments at various levels have been involved in bicycle safety and management. The key policy document guiding actions is the Bicycle Law passed in 1980 by the Japanese Diet. Cyclists are required to register their bicycles and to use appropriate safety equipment, such as lights and working brakes. Although penalties for failure to observe the law are provided, enforcement is virtually nonexistent.

Bicycle accidents by age group in Japan show no significant difference from Australia and New Zealand. In both Japan and Australia, about half of all bicycle accident victims are under the age of 20 years.[72]

Encouraging Bicycle Transportation

Official bicycle committees at various government levels can often make a big difference in encouraging bicycle programs, planning, and investment, facilitating communication and coordination between planners, policymakers, activists, and others concerned with bicycle transportation.

In Australia, State Bicycle Committees were operating in the four states with the greatest population in 1987, Victoria, New South Wales, South Australia, and Western Australia. Metropolitan bicycle plans had been prepared in six major cities—Perth, Geelong, Melbourne, Newcastle, Townsville, and Canberra—and were in various stages of implementation, with plans in preparation in four additional cities—Brisbane, Sydney, Hobart, and Adelaide.[73] Six capital cities had bicycle advocacy groups in place. Together, these organizations constitute a significant voice for bicycle transportation interests.

State governments in Australia have the primary responsibility to set policies and budgets for education, roads, and police, although agencies are accountable at a regional level in responding to local needs and financial requirements. State Bicycle Committees are usually located within the highway agency of the State. They do not administer funding for projects, but rather advise governments on bicycle issues, coordinate various actors related to bicycle programs, and identify and monitor programs. Committee members represent road safety organizations, government departments, the bicycle industry, and users. Typical of the products of these groups is the Bicycle Strategy for the State of Victoria, shown in figure 13.

At the local level, bicycle plans are developed by municipal government following guidelines set by the State Bicycle Committees. Education and enforcement programs are generally tied to the large state education and police department operations.[74]

Bicycle plans have been prepared in several cities in New Zealand, but current information on their status is not readily available within the resources of this study.

Bicycle Helmet Laws

Mandatory helmet laws for bicyclists are a recent Australian innovation. The States of Victoria and New South Wales (NSW) both adopted laws requiring bicyclists to wear helmets, in 1990 and 1991, respectively. In NSW, the law was instituted in two phases: an initial requirement for helmet wearing by those 16 years and older, beginning in January 1991, and a second phase when all cyclists, regardless of age, are required to wear helmets, beginning in July

Figure 13. Bicycle Strategy for Victoria

The Australian State of Victoria, with a population of four million, adopted a Bicycle Strategy in 1990 to provide a 10-year strategic framework for the development of bicycle programs and facilities across Victoria.

The Strategy reflects the philosophy that bicycling is an important part of transport that needs to be incorporated into normal planning processes. It provides for bicycle action from the state to the local area level and covers commuter, recreational, local, and school bicycling.

Strategic action will be directed at:

- Encouragement and Education;
- Network Improvements;
- Cycling Safety; and
- Organization and Coordination.

The specific aims of the Strategy are to:

- ensure that bicyclists have suitable access to road space;
- encourage bicycling for the environmental, recreational and health benefits to bicyclists and the larger community;
- reduce the frequency of bicycle accidents and the severity of injuries resulting from accidents;
- coordinate the provision of bicycling facilities across relevant agencies and organizations;
- ensure planning for bicycles is integrated within overall transport and land use planning;
- give priority to those areas where demand for bicycling is highest;
- monitor bicycling; and
- facilitate ongoing research and investigation of new initiatives.

Funding was not addressed in the Strategy, but it is anticipated that expenditures will continue at a similar rate to the $10 million spent on bicycle programs in 1989.

Source: Sergeant Ted Wilson, "Australia: Bicycle Programs and Promotions from Down Under," *Proceedings of 1990 Pro Bike Conference, Arlington, VA, September 1990,* Bicycle Federation, Washington, DC, p. 121.

1991. On-the-spot fines of A$32 (US $25) for cyclists have been imposed, with more than 1,300 fines levied by March 1991 in NSW alone, following a 1-month warning period.*

Although it is too early for a complete evaluation, preliminary results suggest that the Australian helmet laws have increased the share of cyclists using helmets, but that many people may have given up cycling as a result.[75] This suggests that mandatory helmet laws may be counter to many other social objectives, such as improving air quality, reducing energy consumption, reducing traffic congestion, and promoting alternatives to the automobile. Indeed, the Australian experience with encouraging voluntary helmet use may be a better example for the United States to follow, rather than the Australian experience with mandatory helmet requirements.**

Voluntary helmet use among cyclists in Australia had been rising significantly in the years prior to the new law, thanks to extensive cyclist education and marketing efforts. In Sydney, for example, the share of adult cyclists wearing helmets rose from 5 percent in 1985 to almost 20 percent in 1988 and 31 percent by 1990. In rural areas of NSW and Victoria, helmet wearing rates in 1990 were lower, at 13 to 22 percent. However, after implementation of the new law, in April 1991, an estimated 75–80 percent of adult cyclists in Sydney, Melbourne, and rural NSW and Victoria were wearing helmets.[76]

This result has been attained, in part, by reducing bicycle trips by cyclists who do not care to wear helmets. In Victoria, where the only comparable before-and-after surveys of bicycle use were taken, there was a 9-percent decrease in the number of cyclists in the year following the mandatory helmet law introduction.[77] In the first 6 months after introduction of the Victoria law, the number of cyclists admitted to public hospitals with head injuries decreased by 56 percent, but the number of cyclists admitted with all other injuries (unrelated to whether a helmet is used or not) decreased by 47 percent, suggesting that much less cycling is being done in Victoria since the law went into effect. Further research is needed, but it appears from the evaluation of this experience that the cyclists who stop cycling as a result of mandatory helmet laws are likely those who cycle shorter distances, prefer to ride on sidepaths, have less traffic-oriented cycling skills, and include more women than men.

Among "serious cyclists," defined by the helmet law evaluation study in NSW as "cyclists dressed in cycling clothes (a Tee-shirt and shorts were not counted as cycling clothes) including cycling shoes," helmet use in 1991 appeared to be virtually universal—over 98 percent. "Commuter cyclists," defined as "someone with a backpack on the back or on the bicycle

* Copying and adapting this initiative, at least two U.S. jurisdictions, Montgomery and Howard Counties, in Maryland, both adopted mandatory helmet laws for cyclists age 18 and younger within the past year.

** It is worth noting that a reduction in bicycle use following implementation of a mandatory helmet law would be consistent with what has happened in mandating helmet use for other modes. When helmets became required for motorcycle and moped riders in the Netherlands in the early 1980s and in Japan in 1985, the use of motorcycles and mopeds in both cases diminished significantly.

carrier," showed the next greatest compliance with the new helmet law, at 80 percent. "Recreational cyclists," which the study defined as all others over 16 years of age, showed even lower compliance, with only 6 out of 10 wearing a helmet in 1991. The law did not yet apply to those under 18 years old at the time of the survey. However, only one in 10 secondary school students were seen wearing helmets, although among primary school students, 42 percent of girls and 29 percent of boys used helmets.[78]

While only 2.5 percent of "serious cyclists" were found to use footpaths for cycling in NSW, "commuter cyclists" and "recreational cyclists" did so far more—at a rate of 17 and 28 percent. While only 45 percent of footpath cyclists were observed wearing helmets, 84 percent of on-the-road cyclists were helmet wearers. Little more than half of those cycling on local roads used helmets in Sydney and those cycling on secondary and arterial streets had higher rates of 70–80 percent. Helmet law compliance was also found to generally increase with the age of the cyclist. Women, who make up only about 20 percent of all adult cyclists in NSW, were found to have lower rates of helmet use than men prior to the new law (22 vs. 26 percent). After implementation of the law, this difference narrowed to 77.1 percent compliance for adult male cyclists and 75.5 percent for adult female cyclists.[79] This may be due to decreased participation in cycling by women as a result of the mandatory helmet law, but further research is needed to firmly establish this.

Many Australian bicycle activists argue that mandatory helmet laws make more sense for motor vehicle drivers than for bicyclists, given that 7,500 Australian motorists each year receive head injuries in accidents, leaving about 250 as living vegetables and another 1,000 permanently disabled, while only 100 cyclists a year in Australia die from injuries of all types.[80] The replacement of helmet use encouragement programs with mandatory laws may also encourage bicycle helmet purchasers to shift from helmets that offer good protection to helmets that are cheap, but often offer little protection in an accident.

No information on helmet laws and practices in New Zealand is readily available within the scope of this study.

Vehicle Registration and Taxation

Bicycle registration, which is weakly provided in a few United States communities, is uncommon or not reported on in the literature in any of the countries in the region that is the subject of this study. However, motor vehicle licensing is commonly used to raise revenue, to ensure vehicle safety, and to regulate vehicle use in all the countries of this study.

Cycle-rickshaw registration laws are pervasive in the cities of India, Bangladesh, Indonesia, and other countries of Asia where these vehicles are found in great number. Nonetheless, a very large share of cycle-rickshaws operate in violation of these laws, usually because the number of legal registrations has been severely limited and new registrations are often unavailable.

In many cities in Asia, vehicle registration has been used to try to suppress cycle-rickshaws and other informal sector public transport services, such as jeepnies, jitneys, motorized auto-rickshaws, and pirate taxis. In Karachi, cycle-rickshaws were banned in 1960 and replaced by auto-rickshaws, which in turn were subjected to restrictions on new registrations from 1986 onwards. In Manila, the motorized tricycles which replaced banned cycle-rickshaws in the 1950s were themselves later banned from main roads, and now operate mostly on smaller roads as feeder services.[81] Only in Singapore have restrictions been placed on private motor vehicle registrations, beginning in 1990, although such vehicles are the least efficient users of road space in Asian cities.

In a number of cities in India, Indonesia, and Bangladesh, restrictions have been placed on the number of cycle-rickshaw registrations that will be permitted, often freezing registrations at a fixed level for many years. Restrictions on licenses create a lucrative black market in duplicate or falsified licenses. It also makes cycle-rickshaw drivers and owners vulnerable to extortion and abuse from local police, who can threaten to seize their vehicle, causing at a minimum, loss of a full day's pay and at worst, loss of livelihood. Indeed, Jakarta authorities have seized some 100,000 cycle-rickshaws in the past 5 years, dumping at least 35,000 into Jakarta Bay, as they seek the complete elimination of these vehicles from the city. Thousands more cycle-rickshaws have been seized and destroyed in Delhi in the late 1980s. Wherever rickshaws are licensed in Bangladesh, cycle-rickshaw pullers must also hold driver's licenses, under laws that date back to the 1920s. However, in many cities as few as 15 percent of all pullers are actually licensed. Although the licensing fees are usually minimal—on the order of one-tenth of a day's income—it typically takes 10 or more times this amount to secure a license, as a number of signatures and bribes are required.[82]

Such excessive and heavyhanded regulation reduces the potential of nonmotorized modes to meet community needs and threatens modal diversity. A key objective of urban transportation system development and management should be the preservation of modal diversity, so that travelers can choose among multiple competing travel modes to select the one that offers the highest efficiency of resource utilization and acceptable speed and comfort within a limited budget. When modal diversity decreases, people are often left with no choice but to use an inefficient travel mode or to give up traveling altogether. Market forces can work in transportation mode choice only when multiple choices are available and given a level playing field on which to compete. This sometimes requires protecting weaker but desirable modes of nonmotorized transport from stronger but less efficient motorized transport mode, just as economic regulation is sometimes needed to ensure competition and prevent the emergence of monopoly or oligopoly in other markets. However, rather than protecting NMVs, some governments in Asia have put into place policies to suppress NMV use, particularly cycle-rickshaws.

Many cities have imposed constraints on nonmotorized modes of travel, particularly cycle-rickshaws, claiming these cause congestion or unfairly exploit human labor, or that they represent backwardness. In Kuala Lampur, Malaysia, and Jakarta, Indonesia, cycle-rickshaws have been mostly displaced by such measures. The suppression of cycle-rickshaws has reduced the modal diversity of many Asian cities, in many cases eliminating a major source of employment for low-income people while stimulating the use of motorized three-wheel taxis, which are a major source of air pollution. Just as the destruction of rain forests eliminates species diversity and is reversed only with great time and difficulty, so too does the elimination of nonmotorized modes reduces modal diversity and is reversed only with great effort.

Chinese transport policies have been quite different from this pattern. In the 1950s, China began offering employee commuter subsidies for those bicycling to work, accelerated bicycle production, and allocated extensive urban street space to bicycle traffic. Today, 50 to 80 percent of urban trips in China are by bicycle, while providing travel speeds comparable to those of many other more motorized Asian cities, with much more favorable consequences on the environment and petroleum dependency. Many planners in Chinese cities have been discussing problems caused by widespread violation of traffic regulations by cyclists. Very heavy bicycle traffic flows frequently lead to overflow of cycle traffic into motorized traffic lanes and violation of traffic signals. Many Chinese planners call for public education about traffic regulations. In many Chinese cities, workers have recently been organized to help the police enforce traffic order. The Chinese Government stopped collecting a use tax for bicycles in 1980. Some Chinese planners suggest a restoration of such fees to slow further growth of bicycle ownership. Most Chinese transport experts agree or tend to agree that different policies need to be pursued in cities of different sizes. In small cities of up to several million population, bicycle use should not be limited. In large cities with severe bicycle traffic congestion, bus, subway, and rail public transport should be better developed to attract long-distance cyclists, reducing mean bicycle trip lengths. Many think that costs of bicycle use should increase to moderate further bicycle fleet growth.[83]

VI. Economic and Environmental Considerations

Energy and Environmental Factors

Walking and cycling are the most environmentally friendly modes of transportation, and their high levels of use is one of the reasons why citizens in the affluent Asian cities of Tokyo, Hong Kong, and Singapore together use on average one-tenth as much gasoline per capita as the United States. In large part, because residents of Australian cities walk and cycle less, they use five times more gasoline per capita than residents of Asian cities.

A pioneering study by two Australians, Newman and Kenworthy, has looked at a number of factors influencing gasoline use in different parts of metropolitan areas, accounting for the interaction of land use and transportation. While their data have certain limitations, they provide strong evidence that not more than half of the variation in gasoline use between cities can be explained by vehicle size, income, and gasoline price. Urban form, such as the density of jobs and residents and central city strength play a major role in explaining this variation, along with the degree to which cities accommodate the automobile with infrastructure and parking. Cities that have high public transport speeds and low automobile speeds, which also usually have high walk and bicycle mode shares, generally have the lowest gasoline use per capita.[84]

In China, where nonmotorized transportation predominates for short and moderate-length journeys and where railways account for a major share of long-distance transport, only 7 percent of energy consumption was accounted for by transportation in 1985, compared with 24 percent in South and East Asia and 33 percent in Latin America. The transport sector consumed only 13 percent of all oil used in China, but 35 percent in the remainder of Asia, where motorization is more advanced, and 62 percent in the automobile-dependent United States.[85]

Walking and cycling are seen by an increasing number of planners and policy analysts in Japan, Asia, and Australia as modes that can contribute to reducing Carbon Dioxide (CO^2) emissions from transportation. A recent substantial rise in global atmospheric CO_2 levels is one of the most important factors accounting for rising average global temperatures. While there is continuing dispute over the pace at which global warming will occur, few scientists dispute that such warming is occurring or that global climate change poses a potentially serious threat to the earth's environment and economic and political stability.

Motor vehicles account for about 17 percent of global CO_2 emissions, but their share is growing. If current trends continue, transportation will likely contribute more to global climate change over the next century than even the destruction of tropical rain forests.[86] UN experts have estimated that greenhouse gas emissions would have to be reduced immediately by 60 percent to stabilize greenhouse gas levels in the atmosphere at today's levels.

As one Australian researcher has shown, automobiles are a major source of CO_2 emissions, as table 6 illustrates, while bicycles and walking contribute almost nothing, other than the modest products of human respiration during exercise.

Like a large share of affluent industrialized countries, Australia has recently agreed to adopt a goal of reducing its CO_2 emissions to 80 percent of their 1988 levels by 2005 to help slow the pace of global climate change, although a 50-percent increase in emissions was forecast as recently as 1987.[87] More recently, the Australian and New Zealand Environmental Council recommended the need to investigate options for reducing CO_2 emissions by 40 percent below 1988 levels.

Table 6. CO^2 Emissions by Mode of Transportation

Mode	CO_2 Emissions (Grams/Passenger-Mile)
Automobile	85
Jet Airplane	65
Diesel Bus	15
Railway	15
Light Rail	10
Trolley Bus	8
Walking	4
Cycling	2

Source: Alan A Parker, "Critical Paths," *Cycling World*, March-April 1991, p. 34.

Australia faces many of the same challenges as the United States in responding to growing international demands for CO_2 reduction. The Ministry of Transport in Victoria, for example, is forecasting an 85 percent increase in car travel by 2005 and is planning to cope with this increase instead of seeking to reduce automobile dependence.[88] Many transport activists are pressing for the inclusion of measures to increase the cost of driving, encourage ridesharing, and boost the use of bicycles for short trips and for access to improved public transportation.[89] Figure 14 shows a scenario developed by the Town and Country Planning Association, in Melbourne, to reduce car fuel use by 60 percent in 2005 through a variety of such measures.

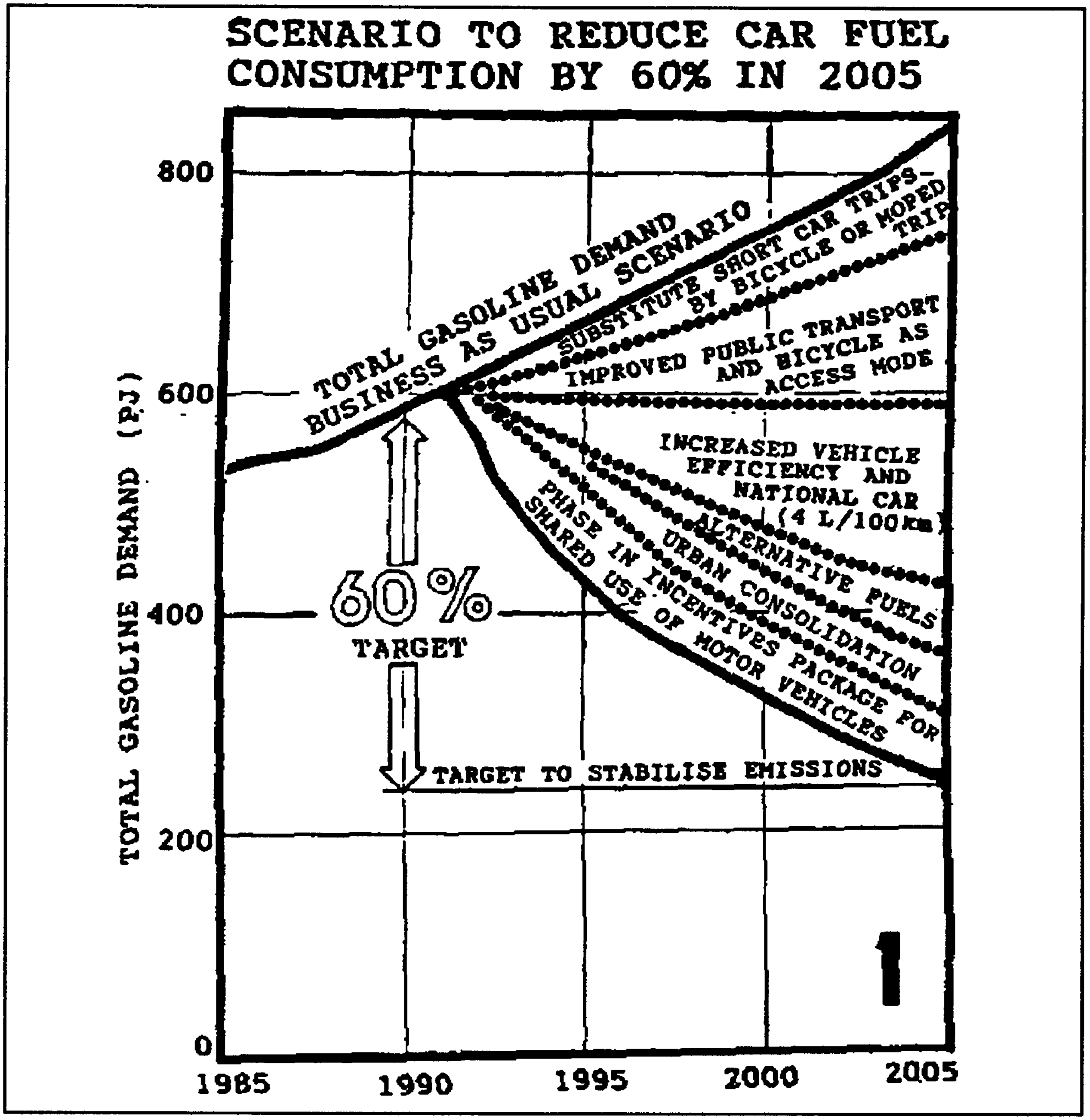


Figure 14. A Proposed Strategy for Reducing Australia's CO_2 Emissions (reprinted by permission of Alan A. Parker)

Like several countries in Europe, Japan is making significant efforts to further reduce its emissions of CO_2, which are already among the lowest on a relative per capita basis for a wealthy industrialized country. With a large share of its population living in coastal zones, Japan takes seriously the threat of a significant rise in global sea level due to global climate change. Steps being taken in the transportation sector include making major improvements in vehicle fuel economy, improved traffic management, development of very high-speed rail and MAGLEV systems, continued enhancement of public transportation, walking, and cycling, and land use growth management.

Costs and Expenditures

Australia. Funding for bicycle and pedestrian programs and facilities in Australia has remained at very low levels for several decades, while concentrating on road development, as in the United States. The emphasis in Australian bicycle and pedestrian programs has thus remained focused on education, research, and enforcement, along with low-cost engineering and encouragement programs, compared to European countries or Japan. Comprehensive spending data are unfortunately not readily available, and studies of the cost-effectiveness of bicycle and pedestrian programs appear to be rare and generally unreported in the literature. However, several examples may convey the situation. Figure 15 shows how one Australian community, the sub-regional center of Fremantle, near Perth, evaluated the cost-effectiveness of its bicycle plan.

In the State of Victoria, for example, funding for bicycle programs is about A$13 million (US $9.9 million), but includes only about A$1 million (US $0.76 million) for bicycle facilities, with the remainder devoted to research and education on safe cycling. In recent years, most funds for bicycle facilities has come from the National Government via Vic Roads, the State Department of Transportation. In 1991, this has changed and national transportation assistance that could be spent on cycling facilities go directly to 206 municipal councils for spending on whatever they choose. The State Bicycle Committee is slowly developing the concept of a grid of bikeable main roads, with off-road path links where possible to promote cycling throughout the Melbourne metropolitan area. However, current funding is insufficient to build even the top priority bicycle facility project of 45 that have been identified as part of this Principal Bicycle Network. Bicycle advocates in Victoria are pressing for the commitment of A$40 million (US $30 million) per year to bicycle projects, which would represent 2 percent of the total State transport budget, matching the current bicycle mode share of all trips in the State.[90]

A recent study found that in Perth, Australia, each train journey is subsidized by A$6.35 (US $4.80), and each bus trip by A$1.92 (US $1.45). In comparison, the total State funding for bicycle transportation is about A$3 (US $2.30) per cyclist per year, composed of A$680,000 (US $515,000) per year to the state government bicycle planning and management team plus average expenditures of A$1.36 million (US $1.04 million) per year on dual-use pedestrian-bicycle facilities.[91,92]

Figure 15. Fremantle Network Bike Plan: Showing Costs and Benefits to Build Community Support

While chronic low levels of funding for bicycle programs leave much to be desired in the quality of the cycling environment in most of Australia, available funds can be spent in highly cost-effective ways. Fremantle, Australia, a sub-regional center of about 25,000 people near Perth, produced a notable bike plan evaluation, working with very modest resources but carefully demonstrating the cost-effectiveness of the community's investment in bicycle facilities and programs. The evaluation of the plan looked at a number of indicators to calculate a cost-benefit ratio of 1.46:1 for the 1985-87 implementation period of the Fremantle Network Bike Plan, not counting social and environmental benefits. A 12 percent annual increase in the cycling population was estimated to bring transport and health savings to the community of A$420,000 per year, compared to implementation costs of A$273,000 per year (A$1=US $0.76). The key indicators used were:

- **Medical savings,** evaluated by using police and health department records and estimating accident reduction injury costs. This evaluation factor was later dropped due to estimation problems.
- **Transport costs,** evaluated using travel diaries and traffic counts to estimate mode choice changes, bicycle volumes, and the number of bicycles at schools for calculation of the running cost differences between resulting car and bicycle trips. This was the area of greatest financial benefit.
- **Energy savings,** evaluated using travel surveys from 1980 and 1986, along with the national census data, to evaluate bicycle travel replacing automobile travel and resulting fuel savings. This was a very small component of total benefits.
- **Health benefits,** evaluated through use of traffic counts, surveys, and bicycle sales data to assess the number of new cyclists times the effective reduction in annual health insurance premiums (estimated as A$10 per year for every fit cyclist traveling 30 km/wk or more by bicycle). This was also a relatively small component of total estimated benefits.
- **Community attitudes,** evaluated through a 1987 interview survey.

Development of the Fremantle Bike Plan took place over a period of a decade, beginning in the early 1970s, with calls for cycle paths and taking root in 1983 with presentation of the first plan to the Fremantle Council, with priorities established based on surveys to schools and homes and on-bicycle surveys. After a year of consideration, the Council established funding for municipal and consultant support to develop a revised plan. High-stress busy roads were identified and where possible alternative safer cyclist routes using quiet local streets were selected for improvements. The Council adopted the "Safer Cycling in Fremantle" route plan in 1985, with a proposed network of 10 safer cycling routes to promote commuter, school, shopping, and recreational cycling, with the following design principles:

- To be just as continuous as the parallel main route.
- To relate to the desire-lines of cyclists.
- Gradients to be favorable.
- The riding surface to be clean and continuous.
- Traffic volumes and speeds to be low.

The plan also identified the need for wider curbside lanes on some main roads and proposed development of bicycle/pedestrian paths where they provided linkages in the network or for major recreational locations. A number of traffic-calming strategies were employed to slow traffic at intersections of streets forming part of the alternative route network, such as median islands to enable two-stage crossings by cyclists and pedestrians while slowing motor vehicle traffic. In all, the Plan included nine such refuge medians, seven intersection entrance treatments including speed humps and chokers, 3.2 km (2 mi) of 3.0 m (9.7') wide asphalt bicycle/pedestrian paths, 4.4 km (2.7 mi) of 2.0 m (6.5') wide concrete bicycle/pedestrian paths, and 25 bicycle parking installations. Some of these treatments went unconstructed due to opposition from bus drivers to speed humps and opposition of residents to loss of on-street parking next to islands.

Source: Rex Campbell, *Bicycle Friendly City: Evaluation of the Fremantle Bike Plan 1980-87,* City of Fremantle, Western Australia, 1987.

As a popular Australian cycling magazine recently noted, in Brisbane, Australia, "the same old problems exist here as elsewhere: parallel grates on drains, lack of driver awareness, dangerous traffic conditions, lack of funding for cycling facilities, uninformed bureaucrats making decisions, negative attitudes from police plus a total ban on bicycles on suburban trains."[93] Spending on cycling in Brisbane has gone from an average of A$60,000 (US $46,000) per year between 1977 and 1983 to A$120,000 (US $91,000) between 1983 and 1987. Bicycle construction funding in 1988, an election year, rose to A$2.1 million (US $1.6 million), but immediately after the election, the funding was cut back to zero. After strong lobbying by local activists, A$500,000 (US $380,000) in funding was restored. All of this has resulted in a network of "67 km (41 miles) of recreational paths and routes often completely unmaintained, with overhanging trees, bad lighting, blind corners, and high volumes of pedestrian traffic." It includes one bike path, shown as completed in the published cycle plan, that following the Brisbane River, ends abruptly at a solid brick wall that forms part of a loading dock for large trucks, and then recommences just as abruptly on the other side of the wall.[94]

Japan and Asia. Unfortunately, recent data regarding spending on pedestrian and bicycle programs or the cost-effectiveness of these programs in Japan, New Zealand, or other countries in the region are not readily available within the scope of this study. However, it is clear that expenditures in Japan are far higher than in Australia.

For example, in 1978, the Japanese Government offered about 30 billion yen (US $150 million) for a 5-year program to construct 400 bicycle parking facilities at railway stations, which covered one-third of land acquisition costs and one-half of construction costs. By the end of 1979, nearly 60,000 new parking places at 83 locations had been constructed under this assistance plan, at a total cost of about 3.6 billion yen (US $15 million), including 1.5 billion yen (US $6.5 million) in Japanese federal funds.[95]

Assuming constant unit costs for development of bicycle parking spaces in Japan throughout the 1980s, this would imply the expenditure of over half a billion US dollars on bicycle parking at transit stations over the past 14 years. The creation of over 60,000 km (36,600 miles) of bicycle paths and over 90,000 km (55,000 miles) of sidewalks since 1971 in Japan likely represents an expenditure of at least US $3 to $6 billion. Adding to these investments that have been made by the Japanese in extensive traffic-calming measures, pedestrian zone development, and other amenities for pedestrians and cyclists, total expenditures on pedestrian and bicycle infrastructure alone over the past two decades likely represents at least US $8–10 billion.

Cost-Benefit Analysis

Cost-benefit analysis of bicycle and pedestrian programs and investments has rarely been performed. However, the limited analysis that has been published suggests that many programs deliver benefits significantly exceeding costs. Evaluation of two area-wide traffic management schemes in Adelaide demonstrated the effectiveness of traffic-calming measures in reducing accident rates and producing cost-benefit ratios of 10:1 for a scheme involving mainly road closures and 1.2:1 for a scheme consisting of intersection treatments and road narrowing.[96] Studies in Sydney have also found cost-benefit ratios exceeding one for local area traffic management measures there.[97]

Controlled studies in Great Britain, noted by Australian planners, found that "savings of about 10 percent of total injury accidents on all roads in the study area can be expected from an area-wide approach to improving roads for safety purposes (including measures to discourage use of residential roads for through travel.) Accident reductions were particularly large on the residential roads. The average first-year rate of return (accident savings divided by the cost of improvements) was 38 percent."[98]

These analyses have focused narrowly on accident reductions and similar short-term benefits. However, it is clear that to the extent that pedestrian and bicycle trips reduce the use of automobiles, they can provide substantial benefits in air pollution emission reductions, reductions in road maintenance and traffic congestion, potential deferral of new road investment costs, and improved health of the cyclist. To capture the full costs and benefits of pedestrian and bicycle programs would require the development of long-term, least-cost transportation and land use models and analytic frameworks. While such systems are now being discussed as a possible extension of more conventional models for transportation, land use, air quality, energy use, and metropolitan economies, they are still at least several years from proper demonstration. Scenario-based modeling approaches, that explore and evaluate alternative transportation and land use policies and strategies in a given region, offer promise for more rigorous examination of choices and tradeoffs.[99] Further research is needed on the factors influencing walking and cycling, within the broad framework of activity analysis and overall travel behavior. Geographic information systems (GIS) offer promise for the development of analytically rigorous databases on the microscale pattern of communities and their urban design, including factors that influence pedestrian and bicycle friendliness.[100] However, the literature in this area remains very scarce. Within its resources, this study is unfortunately unable to identify the current state of research in Japan or Australia in these areas.

VII. Lessons for U.S. Transportation Policy

There are many strategies for promoting bicycle and pedestrian transportation found in Asia, Australia, and New Zealand that are potentially transferable to the United States. It is important to recognize that the current overwhelming automobile dependence in most American communities is not irreversible. Americans can be offered more freedom to choose how they travel by enhancing the environment for pedestrians and cyclists, by promoting more clustered and mixed-use development focused on public transportation routes, and by equalizing commuter subsidies, which now favor the automobile.

This survey of the region of Asia, Australia, and New Zealand suggests that across societies, the substantial variation in the use of bicycling and walking modes cannot be very well explained by income, climate, and the level of motorization, although clearly these have some effect. How these modes are perceived socially, how safe people feel walking and cycling, and particularly, the character of land use and urban design, and transportation pricing, all appear to play greater roles in determining the level of walking and cycling. While land use and many elements of urban design change relatively slowly, street space allocation and transportation pricing are subject to short-term changes and can be modified by transportation decisionmakers. Perceptions of transportation modes can be influenced in the short run through marketing, political and social leadership, and the media. These are tools that should be examined by U.S. transportation planners and policymakers as part of transportation demand management plans required by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act. The experience of Asia and Europe can offer guidance on what such tools can accomplish.

Australia's experience helps to show the limits of what may be achievable in promoting walking, cycling, and public transportation in an automobile-dependent country lacking a strong financial and policy commitment to improving the bicycle, pedestrian, and transit friendliness of streets and cities. As has been the U.S. experience, without significant changes in policy, transportation pricing, and a commitment of adequate resources, only modest positive changes in modal orientation away from the automobile can be anticipated. Bicycles, walking, and public transportation will play in most places only a minor role in mobility unless the total transportation system is made more pedestrian and bicycle friendly, and development patterns begin to move towards more clustered mixes of uses that can favor short trips and public transportation.

Japan's highly efficient and energy-conserving transportation systems illustrate how well this can work. There, bicycling and walking are important as both primary and complementary modes in the modern transportation systems of a highly affluent country. Without extensive use of these nonmotorized modes, Japan's cities could not function, public transportation access systems would not work, and the increased demands for energy, street space, and highway investment could not be feasibly met.

As in the United States, suburbanization brought significant changes in Japanese mobility patterns, but in substantially different directions. While walking and bus travel appear to have declined in recent decades in Japan, bicycle and automobile use has grown, along with continued heavy reliance on rail transportation. In the United States, by contrast, all public transportation has lost substantial market share, and walking and bicycling have almost disappeared from many communities, although bicycling has rebounded in the past decade to double its small share of trips.

Although bicycle ownership in Japan and the United States are comparable, the character of use differs greatly. In the United States, bicycles are predominantly used for recreation, and relatively little for commuting and shopping trips. In Japan, this pattern is reversed. Utilitarian cycling has grown significantly in the United States in recent years, however, as has the recreational use of bicycles in Japan. Moreover, women cycle far less than men in the United States, while in Japan, women use bicycles almost as much as men. These differences are largely a result of the character of the bicycling and driving environment, land use patterns, and the pricing of automobile transportation, which remains subsidized in the U.S. and heavily taxed in Japan.

Utilitarian bicycling requires some degree of courage and training in most U.S. communities, while in Japan, less skilled cyclists are able to make use of this mode of transportation, thanks to a more bicycle-friendly environment. If bicycling is to become far more widespread in American communities, education, encouragement, and enforcement of sound traffic laws may help, but they will not be sufficient. Only by combining these measures with improved engineering and operation of streets and more pedestrian- and bicycle-friendly land use and urban design will the vast majority of U.S. bicyclists begin to see merit in using their bicycle for more than a trip in the park on Sundays.

Pedestrians too need a friendier environment in which to travel and conduct daily activities. Although some changes will come only slowly, there are a number of steps that can be taken by transportation professionals and decisionmakers to promote bicycle and pedestrian travel in America. A variety of pedestrian and bicycle strategies and programs have been reviewed by this study which merit consideration for transfer to the United States. These include:

Pedestrian Amenities for the Visually Disabled. Japanese pedestrian amenities, such as information systems for the visually disabled, merit examination in greater depth by U.S. urban designers and transportation planners. Many of these systems could be readily transferred to the U.S. context and would support implementation of the Americans with Disabilities Act of 1990. Other information systems for pedestrians being tested in Japan might offer a new dimension to the IVHS research agenda of the U.S Department of Transportation.

Pedestrian Overpasses. American transportation planners should note the experience of Japan with pedestrian overpasses. After installing more than 9,000 of these in the late 1960s and early 1970s, the Japanese mostly ceased such construction, preferring instead to improve conditions for pedestrians at ground level or, in some cases, to provide underground passageways. As in many other countries, overpasses offer a second-class treatment to pedestrians, forcing them to climb up and down and around, rather than offering a direct path.

Part-Time Pedestrian Zones. The use of part-time pedestrian zones, while uncommon in the United States outside of the New York City Financial district, is widespread in Japan, and should be considered for more U.S. communities. By allowing automobile and truck access in the early mornings and restricting access to pedestrians and cyclists in the mid-day and evening, such zones enable pickup and delivery needs to be met without losing opportunities to create lively people places and retail spaces during other parts of the day.

Traffic Calming. The traffic-calming strategies being pursued in Japan and Australia, like those in Europe, are already finding application in a growing number of U.S. communities, including Seattle, Boston, Palo Alto, and Boulder. The experience of both Australia and Japan in this area merits closer examination for potential transfer to the United States. Many American officials, trained to identify ways to speed up traffic and increase highway capacity, find the idea of traffic-calming strange or unacceptable, and indeed, some object to the very term. Revised handbooks, textbooks, and training materials and courses are needed to transfer the best of the foreign experience to the U.S. context and to build on the growing base of domestic experience in this area. Revised street design standards and guidelines should be considered to aid the retrofitting of streets designed primarily for motor vehicle circulation. Traffic-calming appears to be one of the more cost-effective ways to promote pedestrian and bicycle use in urban and suburban areas, where walking and bicycling are often hazardous and uncomfortable.

Pedestrian and Bicycle Priority Areas. The Japanese and Australians are both expanding the application of traffic-calming strategies across whole networks of streets in areas where pedestrians and bicycles are given priority, creating "environmental areas," or "road-pia." This concept is very important for its potential application in U.S. communities, in residential areas that suffer from excessive cut-through traffic, in commercial areas, and in the vicinity of major transit stations and stops. Some U.S. communities have already adopted these concepts, such as Palo Alto, California.

Traffic Cells. The traffic cell systems that are in increasing use in Japanese cities, such as Nagoya and Osaka, merit greater examination by U.S. transportation planners. Like their counterparts in Europe, these have proven very effective in discouraging through traffic and shifting short trips within the area to nonmotorized or public transportation modes. They can be relatively inexpensive to implement and offer major potential for air pollution reduction through the elimination of short trips, with their cold starts and hot soaks. The Downtown Crossing in Boston, Massachusetts, represents a successful demonstration of this concept in a major U.S. city, but other demonstrations are needed.

Bicycle Facility Design. Bicycle facility designs, especially those found in Japan, offer fresh ideas for bikeway and bikelane planners in the United States. These designs should be analyzed in greater depth and packaged to make them available to U.S. bicycle planners and highway engineers. Particular attention might focus on intersection treatments for bikeways along highways. The Japanese experience with shared bicycle-pedestrian paths could be evaluated for guidance on when it is appropriate to separate these modes to enhance safety and system performance.

Bicycle Network Design. The experience of Japan, China, and Australia suggests that creating denser networks of bicycle-friendly paths, lanes, and roads is important if more than a small minority of the population is to find utilitarian cycling attractive in an otherwise motor vehicle-dominated environment. Indeed, the American experience thus far validates this as well. Bicycle use is generally highest in the urban areas where steps have been taken to create local networks for safe cycling, such as Eugene, Oregon, Davis, California, Madison, Wisconsin, or Seattle, Washington. Network elements are needed at different functional levels, from the neighborhood and district to the regional level. Various types of facilities can compose the network, from mixed traffic streets that are bicycle friendly, to fully separated bicycle paths. Fragmented and isolated bicycle facilities that fail to form a well-interconnected network will have far less effectiveness than integrated systems. The Japanese experience suggests that to be most successful in stimulating bicycle use, cycling networks should penetrate into the hearts of major urban and suburban centers, to reach rail stations, employment centers, and retail areas, connecting them to residential areas and schools. These concepts need further evaluation and demonstration in the U.S. context and should be incorporated into traffic engineering manuals and training.

Bike-and-Ride Systems. The Japanese systems for bike-and-ride travel, with efficient and easy-to-use guarded bicycle parking at transit stations, offer important designs and service concepts that can enhance public transportation efficiency and effectiveness, reduce automobile dependence, and cut transit operating costs. The development and evaluation of guarded bicycle parking garages holding 500 or more bicycles at U.S. transit stations should be considered, with a comparison to the bicycle locker and rack systems that are the prevalent practice. Such demonstration projects should be undertaken in conjunction with measures to ensure that bicycle-friendly streets and paths lead to transit stations. The best candidate sites for such activities are at stations where there is little or no automobile park-and-ride access and where many residents and jobs are found one-half mile to 2 miles from the station. Additional in-depth studies of the bicycle parking and rental systems for transit and activity centers found in Japan and Europe could enhance prospects for a successful adaption of some of these approaches to the U.S. context.

Pedestrian and Bicycle Supportive Land Use Planning. The experience of Asia, Australia, and New Zealand also shows the importance of land use planning and policy on bicycle and pedestrian travel. Low-density homogeneous automobile-oriented land use patterns are inherently hostile to pedestrians and cyclists, making trip quality and lengths too great for nonmotorized modes to serve much purpose. Moderate and higher density mixed-use patterns of land development, as are found in Japan and many Asian cities, favor far greater use of walking and cycling by reducing the distance people must travel to meet daily activity needs. Devotion of extensive land area to automobile parking typically increases separation between land uses, reducing walking and cycling while making for a less pleasant and less safe environment for traveling by these modes. Restricting parking supply, encouraging minimal building setbacks, placing parking behind buildings rather than in front, and encouraging small retail establishments in residential areas can all promote walking and cycling. Such policies merit encouragement as strategies for transportation demand management and air quality improvement in the United States. Valuable American experience is being gained in pedestrian supportive land use planning in a number of recently developed neo-traditional planned communities in places ranging from Seaside, Florida, to Sacramento, California.

Commuter Subsidies and Pricing. Current transportation choices in the United States are often seriously distorted by subsidies for the automobile user. Combined with a critical fiscal crisis at every level of Government that inhibits transportation investment to meet the needs of an overburdened transportation system, this provides a sound rationale for pricing reforms in transportation. Users of automobiles in Japan pay automobile registration fees and parking fines roughly 100 times higher than those incurred by American drivers, although their per capita income exceeds that of Americans by only a small amount. Gasoline is taxed in Japan to make it four times more expensive than in the United States. Toll roads are common and cost 10 to 30 times more per mile than in the United States. The federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) gives new flexibility for user fees and innovative pricing techniques in transportation. U.S. States and local governments might consider how to use such strategies to generate revenues to meet community needs while sending appropriate price signals to single-occupant automobile drivers and other travelers. Without such price reforms, public transportation will continue to require increasing subsidies and there is little hope that transportation demand management will be effective. Japan's experience suggests that high user fees for automobile use provide a very supportive economic context for promoting walking and bicycling, which generally have intrinsically low economic costs for both users and society when used for short trips.

The 4-E's Approach to Bicycle Promotion. The 4-E's approach to bicycle transportation, "Education, Engineering, Enforcement, and Encouragement," has been the foundation of much work in Australia. This more comprehensive framework for promoting bicycling has already had much influence in the United States among bicycle planners. However, in both Australia and the United States, the 4-E's approach has not fully lived up to its promise and has been particularly limited by a frequent lack of strong Government support and financial commitment to the strategy. Greater support for the 4-E's approach can be facilitated if State and local governments make use of ISTEA's provisions of new funding for transportation enhancements under the Surface Transportation Program, under the Air Quality/Congestion Management funding program. Under the flexibility provisions of the Act, States can tap a wide variety of other Federal transportation funds to support pedestrian and bicycle transportation, all with an 80-20 Federal-local matching ratio. Indeed, under ISTEA, States are now required to appoint bicycle and pedestrian coordinators and States and regions must develop long-range plans for bicycle facilities and walkways.

Bicycle Education. The Australians, in particular, have developed a number of effective programs in bicycle education that have some potential for transfer to the United States. Safety education programs directed toward children throughout their school years, especially including on-road bicycle training, appear to be very effective in improving bicycle safety.

Bicycle Helmet Encouragement and Laws. Australia offers the United States good examples of successful bicycle helmet encouragement programs, but also offers a cautionary experience in making helmet use mandatory. The recent requirement for all bicyclists to wear helmets, under threat of fines, appears to have reduced the use of bicycles, and thus has worked against other goals of reducing automobile use and air pollution. Mandatory helmet laws for cyclists in the United States should be reconsidered in light of this experience. Existing mandatory laws should be closely evaluated for their comprehensive effects.

Impacts on Energy Use and Air Pollution. When bicycle and walking trips substitute for motorized transportation, they can have a significant effect on energy use, air pollution, and emissions of greenhouse gases. Adoption by U.S. communities of some of the transportation and land use policies of Japan that encourage more walking and cycling could help attain the goals of the Clean Air Act and contribute to reducing both petroleum imports and greenhouse gas emissions.

Transportation accounts for 30 percent of U.S. CO_2 emissions, which as a whole amount to a quarter[101] of total global fossil CO_2 emissions. Of these transportation emissions, more than two-thirds come from automobiles and trucks.[102] UN experts have estimated that greenhouse gas emissions would need to be reduced immediately by 60 percent to simply stabilize today's elevated levels of greenhouse gases in the atmosphere.[103] Substitution of walking and cycling for motor vehicle trips can provide a significant reduction in CO_2 and other emissions. Australia and Japan, along with all other industrialized countries other than the United States, have pledged to reduce their CO_2 emissions in coming years to deal with the unprecedented threat of rapid, human-induced global climate change. The United States could join in partnership with these other countries in addressing this problem.

The effects of substituting walking or cycling for motor vehicle trips are particularly pronounced for volatile organic compounds (VOCs), which are disproportionately related to cold starts and hot soaks of motor vehicle engines. For example, the substitution of a bike-and-ride trip for an automobile commute trip reduces air pollution, energy use, and greenhouse emissions far more than diversion of automobile commuters to park-and-ride.

While a short bicycle trip to a transit stop emits no pollution and uses no nonrenewable energy, a short automobile trip creates cold start, hot soak, and running emissions, and typically has very poor fuel economy due to the cold start. While the park-and-ride trip generates less pollution and gasoline use than an automobile commute, the reduction in pollution and energy use is proportionally far less than the reduction in vehicle miles of travel. The VMT-based emission reduction models commonly in use in the United States may overestimate fuel and pollution savings of park-and-ride strategies by 40 to 50 percent by failing to account properly for cold start and hot soak factors. Moreover, bike-and-ride systems cost only one-tenth to one-hundredth the capital and operating cost of park-and-ride systems for transit access.[104] Such factors should be fully considered in the analysis of transportation control measures as part of transportation and air quality planning.

Costs, Benefits, and Expenditures. The financial commitment of governments in the region to pedestrian and bicycle modes is difficult to tally; however, it is clear that Japan and China are both expending significant resources to support greater use of these modes of transport. Japan's expenditures on pedestrian and bicycle infrastructure alone over the past two decades likely exceeds US $8-10 billion, in a country of 125 million population. Per capita expenditures for nonmotorized transportation, particularly bicycles, appear to be far lower in Australia and New Zealand, although comprehensive data are not readily available. Although per capita expenditures on pedestrian and bicycle modes in the United States are likely more comparable to Australia than to Japan, ISTEA provides a supportive framework for increased State and local activities and expenditures in these areas.

Unfortunately, relatively little information on the costs, benefits, and expenditures related to pedestrian and bicycle programs is readily available. Indeed, long-term, least-cost analysis methods that would be needed for a comprehensive assessment of costs and benefits of bicycle and pedestrian programs and strategies are still in the early stages of development around the world.

However, more limited evaluations suggest that many such programs are quite positive in their return on investment. Various traffic-calming measures in Adelaide, Australia, for example, were found to provide cost-benefit ratios of 10:1 to 1.2:1, considering accident costs alone. The Fremantle Bike Plan was estimated to provide a return of 1.46:1 over its first 2 years of implementation. Despite this, a recent study in Perth, Australia, estimated that State funding for bicycle transportation was about US $2.30 per cyclist *per year*, compared to subsidies of US $4.80 per trip *for each train journey* and US $1.45 *per bus trip*.

The Example of China. While China is in many respects too different from the United States to serve as a useful example for the United States, its experience is highly relevant to many low-income communities in the Western Hemisphere. Without its 300 million bicycles, China's economy would falter and its cities would quickly stall in a deadly gridlock of motorcycles, buses, and trucks. China's efficient and very low-cost transportation systems, which rely overwhelmingly on nonmotorized modes for moving people, illustrate the importance of bicycles in meeting mobility needs affordably in low-income countries and communities, just as the transportation systems of Japan and some European countries, such as the Netherlands, illustrates the potential importance of bicycles and walking in efficient, modern cities of high-income countries.

A Final Word. As America seeks to develop a new vision of transportation and land use that will be more sustainable into the next century, it may find it instructive to look to other societies to learn and adopt the best from their experience. There is much to be gained by learning from abroad, and much to be done at home in America to make walking and cycling the modes of choice for short trips for a larger share of the population, while improving the integration of walking and cycling with longer distance modes.

ISTEA and the Clean Air Act provide the flexibility and impetus for U.S. planners, engineers, policymakers, and transportation consumers to begin more actively managing the transportation environment of our communities to favor pedestrians and cyclists. Americans need to once again be able to choose how they travel, with walking and cycling as viable and safe options for short trips and for access to public transportation for longer trips. Walking and bicycling are fundamental elements in moving towards more sustainable transportation systems.

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